UGANDA

Part of Uganda was within the historic range of northern white rhinos and the habitat and climate are similar. It is close to Zaïre for reducing transport time and facilitating metapopulation management.

Uganda has accomplished great strides in the field of wildlife conservation since the settlement of civil disturbance. The country is, at present, considered a "favoured country" by many of the conservation and development donors and is experiencing a period of enormous growth in the wildlife sector. However, the security situation in these areas has not totally stabilized. As a result, key potential sites, such as Ajai Game Reserve, have not been developed to the extent of those in the more southerly parts of the country.

Nevertheless, Uganda's obvious strong political will in support of conservation and their busy development agenda place make them a key player in conservation efforts within the eastern African region. The close proximity of the three potential sites in western Uganda to Garamba make each worthy of consideration. The strengths and constraints on each are detailed below.

AJAI GAME RESERVE (FORMERLY AJAI WHITE RHINO SANCTUARY)

Area visited August 1994
Sources of information: Dr. E.L.Edroma, Director UNP; Game Warden, Ajai Sanctuary

The Ajai Game Reserve is located in the northwestern corner of Uganda, in the West Nile area, bordering the Nile River. The Reserve is the only potential site analyzed which falls within the former range of the northern white rhino. The area was established as the Ajai White Rhino Sanctuary in 1958, in an area previously with reserve status, to protect the northern white rhino that were indigenous there. The hills surrounding the sanctuary have forest reserve status. The area is extremely attractive. Ajai contained northern white rhino until very recent times (in the late 1970s or early 1980s). They are believed exterminated during Uganda's civil war. Its isolation and relatively low priority, historically, to the government of Uganda has resulted in total neglect over the past 20 years. There are, however, recent signs of interest in reviving the Reserve within the Ministry and the wildlife sector, overall.

Ecological Factors

Habitat
The habitat is a mixture of wooded savanna, grasslands, and swamps including *Loudetia-Eragrostis*, *Hyparrhenia*, and *Imperata* communities. The area is considered to be very similar to Garamba and Shambe, in southern Sudan. The habitat is considered excellent for northern white rhino.
Habitat is similar to that of Garamba and Shambe in Sudan, with a sparsely bushed long grassland, swamps and patches of forest. Grassland composition is similar to that of Garamba. The forest patches are occupied by colobus monkeys. Waterbuck, bushbuck, duiker, kob, warthogs and a variety of smaller mammals occur. The status of other wildlife in the Reserve is not well known. Presumably Ajai will be surveyed in an upcoming aerial survey of the country's game reserves and this will provide more information on the status of wildlife in the Reserve.

Size and Carrying Capacity of Area
The area is 155 km^2.

Carrying capacity or maximum stocking rate would depend on the area which could be enclosed and protected. The previous population was previously ecologically viable. Poaching and translocation caused its extinction. If the entire area were to be ring-fenced and secured, at densities similar to

Garamba, carrying capacity would be 47 animals. The founder population size of should not exceed 23 or 24 rhinos.

Historical Range
Ajai is within the true indigenous range.

Health
Veterinary examination would be required, but with a history of previous northern white rhino habitation challenge would probably be minimal. Neither the Uganda National Parks nor the Game Department currently have an active veterinary arm. However, there is talk of one being established in future. At the present time, veterinary care would have to come either through private veterinarians or through an agreement which might be made between the Uganda and Kenya governments for assistance from the KWS Veterinary Services.

Non-ecological Factors

Legal Status/Continuity Arrangements
The legal ownership of the area lies with the central government of Uganda. Any and all negotiations would, however, have to involve the National Parks and the Game Department until such time as the merger of the two has been completed.

Security
Current security is almost non existent. The sanctuary is not fenced and people live right to the borders and roads pass through it, freely used. The only criterion for considering it on this aspect would be if it was designated a National park, as has been suggested by Dr. Edroma and security was adequately improved. This is unlikely in the immediate future.

In the merger process between Uganda National Parks and the Uganda Game Department, there has been talk of upgrading Ajai to National Park status. The Reserve is presently 158 km^2. It is entirely unfenced and there is human settlement up to its borders. There is a public access road which runs through the Reserve and is used to transport people and goods. The Reserve is very beautiful and is believed to have a high tourism potential.

There is no security in force in the Reserve and this situation would only improve with an upgrading to National Park status. If this were to take place, it is unlikely to take anything short of five years. At present, there is also indication of possible Uganda rebel activity building up on the Zaïre side of the border.

Cost Effectiveness and Feasibility
It is currently not cost effective, nor a national top priority, unless the value of re-introducing northern white rhino to a former range was recognized by a funding source as sufficiently valuable for investment.

Proximity
Ajai is the closest site to Garamba (200 - 250 km) and is within the indigenous range. Any translocations from Garamba would very likely have to take place by road. Translocations from the captive population would be logistically very difficult.

Ownership
Ownership agreements would be with a para-statal organization.

MURCHISON FALLS NATIONAL PARK

Area visited several times, most recent August 1994
Sources of information: Dr E.L.Edroma, Director UNP Assistant Park Warden, MFNP; Peter Jenkins, Consultant; R.van Geyseghem (1979) Zur Okologie des nordlichen Breitmulnashorns C.s.cottoni, Lydekker 1908; Tesis, Universitat Kaiserslautern

Over the past two to three years, Murchison Falls National Park (MFNP) has been undergoing a major rehabilitation programme with funding from German GTZ. The Park's infrastructure is being restored, staff have been trained and deployed and security has improved.

Ecological Factors

Habitat
Though not within the true indigenous range of the northern white rhino, there have been a history of previous, successful introductions from Ajai. The habitat in MFNP is varied but the Buligi Triangle provides ample food. On the peninsula, grasslands are dominated by *Hypparhenia filipendula* on which the rhinos introduced long ago did very well. The area, in general, is drier than Garamba, but water availability presents no problem. The habitat has been proven as suitable by the northern white rhino that were introduced in the 1960s.

Size and Carrying Capacity of Area
The MFNP covers an area of over 3,800 km^2.

Under the current Park management programme, there are plans afoot to establish eventually a white rhino sanctuary. The proposed sanctuary would be approximately 90 - 100 km^2 in an area of the Park known as the Buligi Peninsula, with a 10 - 12 km fence securing the peninsula from Paraa, on the Nile, to Pakuba, on Lake Albert. The security of such a large area with so much access from the water on three sides could be very difficult. In 1978 there were 15 northern white rhino ranging over 74 km^2 (van Geyseghem 1979). Hence, an area of 90-100 km^2, could support 25-30 rhinos, possibly 50 or more, but the *Hypparrhenia* grassland could be limiting. However, the introduced rhino which one occurred in MFNP were apparently at very high densities (almost 5.0/km^2) as late as 1978. The maximum founder population should be no larger than 13 - 15 rhinos.

The current status of other large grazing mammals or large predators has not been recently established. However, following severe depletion in the 1970s and 1980s, there would unlikely be any significant competition or threat from either.

Current plans are to stock the proposed sanctuary with southern white rhinos. Clearly, if this plan is implemented, the area would be unsuitable for the translocation of any northern white rhino.

White rhinos of either sub-species are exotic to MFNP. However, if the Uganda government were interested in establishing a rhino sanctuary for the non-native northern white rhino instead of the southern whites, the area could be a desirable one.

Health
Veterinary examination would be required, but with a history of previous introductions the challenge would probably be minimal. Neither the Uganda National Parks nor the Game Department currently have an active veterinary arm. However, there is talk of one being established in future. At the present time, veterinary care would have to come either through private veterinarians or through an agreement which might be made between the Uganda and Kenya governments for assistance from the KWS Veterinary Services.

Non-ecological Factors

Legal Status/Continuity Arrangements
The Ministry of Wildlife, Tourism and Antiquities which oversees both the Uganda National Parks and the Game Department is the relevant branch of government for negotiations.

Security
Current security is not good. Most animals have been poached out of the area in the past, but a GTZ project operational until at least 1999 is rehabilitating the park and re-building security. Scouts are based at the Paraa South head-quarters and a few patrol posts and do foot patrols if called out. A road runs through the park, and on our recent visit a lorry heavily laden with fish was stuck on the road in the park and its occupants lobbied considerable abuse at us as suspected park personnel. There is still civil unrest in the area with occasional bomb explosions directed at people in the surrounding areas.

Future security may be considerably better. Jenkins recommended to the project that a 10-12 km fence be placed across the top of the Buligi Peninsula, site of the previous northern white rhino introductions, and introduce rhinos.

While security has certainly improved within the MFNP it is not considered stable as there is still some civil unrest in the surrounding area.

Cost Effectiveness/Feasibility
Selection of this site would depend upon fencing and effective build up of the ranger force, supported by the GTZ project. There is no source of funds for translocation.

Proximity
MFNP is close to Garamba which would facilitate ease of movement of rhinos between the two. If MFNP were selected as a priority site for the translocation of northern white rhinos, there would have to be further investigation into the logistics of the transfer by road or air.

Historical Range
Though not within the true indigenous range, it is within the previously introduced range.

Ownership of Rhino/Progeny
Ownership agreements would be with a para-statal organization.

QUEEN ELIZABETH NATIONAL PARK

Visited in the past briefly.
Information from Dr. E.L.Edroma, Dr. R. Olivier, Mr. M.Infield
Further investigation needed.

Queen Elizabeth National Park (QENP) is situated in the western part of the Rift Valley between Lake Edward and Lake George. The Park was also designated as a Biosphere Reserve in 1979 and is also the site of the Uganda Institute of Ecology. Despite suffering the depreciation of all wildlife areas of Uganda during the war, QENP has received considerable attention under the current Uganda National Parks administration. The QENP is an important tourism area in Uganda and this bodes well for its continuing rehabilitation.

Ecological Factors

Habitat
QENP has areas of extensive grassland, though these are not similar in kind to the grasses of their indigenous range in Garamba, Ajai or southern Sudan. The area has adequate rainfall and presumably sufficient forage, though this would be an important selection consideration for any eventual sanctuary location. The grasslands would probably be adequate. Southern white rhinos have proven to be very adaptable to different grassland habitats under translocation. However, the adjacent Virunga National Park in Zaïre never contained white rhinos in the past. Unlike MFNP, there has been no history of introductions in the past. This leaves a good deal of uncertainty about the suitability of the area.

Size and Carrying Capacity of Area:
The area is almost 2,000 km^2.

The carrying capacity would depend on the area selected. It has been suggested that a very small area (20 km^2) on the Mweya Peninsula could be fenced. At Garamba densities, this proposed Mweya Peninsula site would certainly not be able to hold more than six animals maximum, rendering this an unlikely sanctuary site. The second proposed location has not been identified. Without having any idea of the eventual size of such a proposed sanctuary, there is no way to establish either a maximum founder population size or an eventual carrying capacity.

Historical Range
The QENP is not within the native range of the northern white rhino but is within a country that was a range state. The species' introduction to the area would be as an exotic and would therefore need approval of the highest authorities in Uganda.

Health
Thorough veterinary examination would be required. Information on the Garamba rhinos is given below.

Non-ecological Factors

Legal Status/Continuity Arrangements
The Ministry of Tourism, Wildlife and Antiquities which oversees both the Uganda National Parks and the Game Department is the ultimate authority for QENP. Along the Park's boundaries a number of private concessions have been leased out and these areas have already requested that there be consideration of introduction of southern white rhinos. In early discussions, they have said that they could finance fencing and security but these negotiations have never gone very far and there are no moves at present to do so. Of course, consideration of establishing a northern white rhino sanctuary on privately-leased land in Uganda would be an unprecedented and, possibly, complicated move. The ramifications regarding responsibility for the care and well-bring of the rhinos would be much more difficult in negotiations with private companies than between the governments of Zaïre and Uganda.

Security
There is agreement within Uganda National Parks, that the security situation is best there and Edroma proposes QEP as the most suitable for rhino introduction at present. However, security is not high. Olivier suggests that an area that could be secured is the Mweya Peninsula, which would require only a 200 m. fence and patrolling. However, it would give a region of only about 20 km^2, with park habitation in it. There are suitable grassland areas towards Kasese and at Ishasha, but the latter is close to the Zaïre border and there is poaching.

Around the southern border of the Park are reserves where private companies have long term concessions and are investing in protection. The introduction of southern white rhinos has been proposed. The question again falls upon the relative merits of relying on a private company or a national organization.

Among the potential sites within Uganda, QENP is probably the most secure. However, security cannot be considered adequate. Again, it has been proposed that a small area (20 km) on the Mweya Peninsula could be fenced and patrolled, but the area has human settlement within it. There is a more suitable area, to the west, at Ishasha. But this area would be close to the border with Zaïre, more difficult to secure and more vulnerable to poaching incursions.

Cost Effectiveness/Feasibility
There is no immediate source of funds for fencing or increased security, although the private concessionaires mentioned above could be a possibility.

Proximity
The area is relatively close to Garamba, certainly within flying range but probably too far to move rhinos safely by road. If QENP was chosen as a priority site for translocation, the feasibility of landing a Hercules C-130 transport plane would have to be investigated further.

Ownership of Rhino and Progeny
Ownership agreements would be with a para-statal organization.

SOUTH AFRICA

South Africa, and specifically, the Natal Parks Board, are indisputably the world's leading experts in the conservation and management of the southern white rhino. Today the country is home to the vast majority 95% of the world population of approximately 6,700 southern white rhinos, a number that is greater than the combined total of all other species and subspecies of rhinoceros combined.

The Natal Parks Board, through their Director of Research, (who is the current Chair of the IUCN African Rhino Specialist Group) have played already played an integral role in the planning process towards a northern white rhino management strategy.

Although no specific translocation sites have been identified in South Africa, there is a clear will to be involved and to help identify one or more sites, either on private or state land, that may be appropriate. Security on state lands in South Africa is the best in Africa. However, negotiations on the possibility of a site on state land would probably have to be taken up at high levels of government. Private land ranches and sanctuaries in South Africa would carry a higher security risk. Also, the question of ownership would be more complicated in dealing with private individuals than with the government of South Africa. Most private land rhino programmes in South Africa have been costed on the basis of private ownership, giving individuals full rights over rhinos which they purchase. The northern white rhino situation would clearly require a unique custodianship type arrangement but it is possible and should not be discarded as an option.

While appropriate habitat and space could be located, South Africa is a long way from Garamba for the movement of rhinos. However, it should be kept in mind that South Africa successfully captured, translocated and donated 20 white rhinos to Kenya in 1994; a trip of almost the same distance albeit not as remote.

CZECH REPUBLIC

DVUR KRALOVE

Dvur Kralove is a state operated facility for captive management, propagation, and research in the northeastern part of the Czech Republic. Currently, there are 23 rhino of 3 species at Dvur Kralove.

Ecological Factors

Habitat
It would not be possible at Dvur Kralove to provide a situation where the rhino would obtain most of their nutrition from natural graze. The most limiting condition at Dvur Kralove is the climate with an appreciable number of days and nights with the temperature below freezing.

The breeding programs for both black and southern white rhino have been very successful at Dvur Kralove. A total of 14 black rhino have been produced and there are 4 breeding males and 5 breeding females at the facility. A total of 21 rhinos have been successfully produced at Dvur Kralove. Dvur Kralove is the only captive facility that has succeeded in reproducing northern white rhino. Unfortunately, only one female was involved and this animal died during research manipulation. A total of 3 northern white rhino have been born there; 3 have died there.

Size and Carrying Capacity of Area
Currently, Dvur Kralove has 5 enclosures of .5 to 1 hectare each in size devoted to northern white rhino. These enclosures are or can be interconnected to permit various grouping combinations of the rhino. Further modifications proposed would enhance the flexibility of these facilities. There is another 5+ hectare enclosure adjacent that could conceivably be incorporated into the rhino complex.

Historic Range
Dvur Kralove is not within the historic range of the northern white rhino.

Health
Dvur Kralove has a fully qualified veterinary staff with much experience with 3 species of rhino, including northern white rhino.

Non-Ecological Factors

Legal Status/Continuity Arrangements
Dvur Kralove is currently a state zoo. There have been discussions that the zoo might privatize but there is much sentiment against such a move by the current administration.

Security
Security is good. Little threat of poaching would be expected.

Cost Effectiveness/Feasibility
Dvur Kralove could accommodate a few more female northern white rhino in its current complex of enclosures. However, extensive modifications have been proposed for improved management of the existing collection. Even more modifications would be in order if additional rhino were to be relocated here. Dvur Kralove would not be prepared to provide funds for additional construction or to pay for relocation costs of rhino.

Proximity
Dvur Kralove is not located close to Garamba.

Ownership of Rhino and Progeny

Dvur Kralove owns 8 (3.5) of the 9 northern white rhino in captivity; 3 of their rhino are on breeding loan to the San Diego Wild Animal Park. The breeding loan agreement commits both institutions to global management of the rhino. Presumably, ownership arrangements in the future would be with a state agency in the Czech Republic.

UNITED STATES OF AMERICA

SAN DIEGO WILD ANIMAL PARK

The San Diego Wild Animal Park is a large facility owned by the City of San Diego and operated by the Zoological Society of San Diego for captive management, propagation. research on southwestern California in the United States, about 20 miles inland from the Pacific coast.

Ecological Factors

Habitat
The climate is mediterranean, somewhat seasonal with temperatures normally moderate to hot with a range of 7° to 48° C (20° F to 120° F) with temperatures rarely below freezing during the day but for a total of 21 nights which are dispersed randomly during a 3 month period. Rainfall is about 30 cm (12 inches) per year; extensive irrigation does occur. The vegetation is arid grassland or savannah.

Breeding programs for southern white, black, and Indian rhino have been very successful at the San Diego Wild Animal Park. The numbers of rhino produced here are: 75 southern white rhino; 6 black rhino; and 22 Indian rhino. However, no northern white rhino have reproduced there; 4 northern white rhino have died there.

Size and Carrying Capacity of Area
The facilities used for northern white rhino consist of: the 120 acre East/Central Africa Exhibit which also accommodates many other East/Central African ungulate species; two holding bomas of about 1,000 sq m. each (10,000 sq. ft. each) with an observation deck and a restraint chute to permit hormonal manipulation and reproductive examination of the females and now breeding management of the rhinos. The 2 female rhino are being maintained in one of the holding bomas except when one of them is introduced into the 120 acre exhibit when estrus is suspected. One of the males is kept in the 120 acre exhibit. Until recently, the other male has been accommodated some distance from the other northern white rhino in a 30 acre (10 hectare) enclosure that is separated by a mono-rail track and an average of 50 feet from the 120 acre enclosure. However, the second male will now be maintained in the other of the holding bomas to permit sensory contact and hopefully stimulation of the other rhino. San Diego could accommodate many more female northern white rhino in its current 120 acre enclosure. A large enclosure or a complex of additional enclosures would be required to accommodate multiple males. It would not be possible at San Diego to provide a situation where the rhino would obtain most of their nutrition from natural graze.

Historic Range
San Diego Wild Animal Park is not within the historic range of the northern white rhino.

Health
San Diego has an extensively qualified veterinary staff and facilities with much experience with 3 species of rhino including northern white rhino.

Non-Ecological Factors

Legal Status and Continuity Arrangements

Security
Security is high. There is little to no threat of poaching or other vandalism.

Cost Effectiveness/Feasibility
San Diego has stated it would not be prepared to provide funds for additional construction or to pay for relocation costs of rhino.

Proximity
San Diego is not located close to Garamba.

Ownership of Rhino and Progeny
Dvur Kralove owns 3 (1.2) at the San Diego Wild Animal Park; Khartoum zoo, the other male. The breeding loan agreements commit all 3 institutions to global management of the rhino. Presumably, ownership arrangements in the future would be with the Zoological Society of San Diego.

WHITE OAK CONSERVATION CENTER

White Oak Conservation Center is a highly successful facility owned by the Gilman Paper Company for propagation of and research on large mammals, particularly African, located in northeastern Florida in the United States.

Ecological Factors

Habitat
The environment is sub-topical: normal temperature ranges are 20-35° C (70-95° C) daytime and 10-27° (50-80° F) nighttime with an average of only 16-17 days with temperatures below 0° Centigrade (32° F). Existing southern white and black rhino are provided with infrared heaters, windbreaks, and heavy bedding when temperatures are below 20° C (50° F). No symptoms of cold stress have been observed. Average rainfall is 54 inches (137 centimeters) per year. The vegetation consist of moist forest, both conifer and broadleaf, interspersed with lush pastures dominated by coastal bermuda (*Cynodon maritimus*), fescue (*Festuca arundinacea*), winter rye (*Secale cereale*) and bahia (*Paspalum notatum* var. *Saurae*) grasses that provide excellent grazing for a wide variety of ungulates including pure-bred horses, Grevy's zebra, and white rhinoceros.

White Oak has been highly successful with their programs for southern white rhinoceros with 4 births from a breeding group many of whom were long-term non-breeders at previous locations.

Size and Carrying Capacity of Area
The herd of females currently occupies a pasture of approximately 17 acres. The rhino are grazing extensively. Immediately adjacent are 1 acre enclosures for male rhinos. A facility such as White Oak would not be able to provide the amount of space necessary for successful consolidation of multiple males in a free-ranging situation, for behavioral reasons. Instead, the facility could provide the situation that has proven successful with southern white rhinos, i.e. a free-ranging situation for groups or units of 6-12 females (30-40) acres for each female group/unit, with males in sizable (1-5 acre) adjacent enclosures that would permit much sensory, interaction (including some tactile contact, i.e. fighting through fences) among the males and between them and the females but which would not expose males to significant risk of injurious combat. Depending on the number of rhinos that might be proposed for consolidation at White Oak, the Center would be prepared to provide space and facilities for 2 such units. It is believed enclosures of this size would permit rhino to obtain most of their nutrition from natural graze.

Health
White Oak has a highly qualified veterinary staff and facilities with much experience with 3 species of rhino including southern white rhino.

Historic Range
White Oak is not within the historic range of the northern white rhino.

Non-Ecological Factors

Legal Status and Continuity Arrangements
White Oak Conservation Center is privately owned by the Gilman Paper Company. However, a private Foundation has been established and provisions are in place for the Center to be continued in perpetuity.

Security
Security is extremely high. There is virtually no threat of poaching or other vandalism.

Cost Effectiveness/Feasibility

White Oak would be prepared to pay for construction of all facilities to accommodate any northern white rhino recommended for relocation there. White Oak would also pay for all relocation costs.

Proximity
White Oak is not located close to Garamba.

Ownership of Rhino and Progeny
Ownership arrangements would be with the Gilman Paper Company (private corporation) and its Howard Gilman Foundation (non-profit organization).

SUMMARY

In summary, if any rhino are to be moved from Garamba or from the captive collections to a new site, there must be agreement on and prioritization of criteria for evaluation of suitability of the site. It is suggested that a tabulation of the criteria with some system of priority be used to then evaluate potential sites. The table below is presented as a possible tool for such tabulation and evaluation.

Table 6: An Evaluation Chart for Candidate Sites for New Population of Northern White Rhino

NORTHERN WHITE RHINO RELOCATION SITE CRITERIA & ASSESSMENTS											
SITES	KENYA			UGANDA			RSA	CZECH.	U.S.A.		Zaïre
CRITERIA	Ruma	Ol Pejeta	Shimba Hills	Queen Elizabeth	Murchison Falls	Ajai		Dvur Kralove	SDWAP	White Oak	Garamba
Habitat Suitability											
Carrying Capacity											
Historical Range											
Veterinary											
Legal Status/ Continuity											
Security, Current											
Security, Potential											
Cost Effectiveness											
Cost Feasibility											
Proximity											
Rhino Ownership											
Total Score											

8. SURVEY FOR RHINO IN SUDAN.

According to recent reports, there may still be northern white rhinos remaining in Southern Sudan. If this is true, they may represent a significant proportion of so small a world wide population. A survey is proposed to investigate this further and to assess conservation potentials, within the context of a metapopulation strategy. To this end, a proposal has been prepared for a survey.

PROJECT PROPOSAL

TITLE: SURVEY FOR NORTHERN WHITE RHINOS IN SOUTHERN SUDAN

PROPOSERS: Dr A.K.Kes Smith
Technical Advisor (Ecology), WWF
Garamba National Park, Zaïre
c/o WWF EARO
PO Box 62440, Nairobi

Mr Philip Winter
Save the Children Fund
PO Box 48700, Nairobi

EXECUTANTS: Aaron Nicholas, Emmanuel de Merode, Philip Winter, Kes Smith, Fraser Smith

BUDGET: £16,070 (US$ 25,712)

TIME PERIOD: 6 Months

SUMMARY:

The northern white rhino sub-species (*Ceratotherium simum cottoni*) is one of the most endangered large mammals in Africa. Fewer than 50 remain in the world: 28 to 31 are in Garamba National Park in northern Zaïre, where they are increasing; 9 are in captivity; and there have been recent reports of a few remaining in southern Sudan. It has been recommended by the IUCN African Rhino Specialist Group that the sub-groups of the remaining world population be managed as a metapopulation to ensure the survival of the sub-species. It is vital to ascertain whether any still remain in Sudan, and if so what can be done about them. This proposal is to carry out a survey to achieve this goal.

BACKGROUND

The northern sub-species of white rhinoceros (*Ceratotherium simum cottoni*) occurred, at the beginning of this century in western Uganda, north eastern Zaïre, Southern Sudan, Central African Republic and Chad. Even in 1980, several hundred were believed to exist in Sudan (Hillman 1981). By 1983 a survey was able to confirm only two observations of tracks, in the Shambe area of Sudan, and it was impossible to explore far into Southern National Park due to the security situation at the time (Hillman 1983). Following this the civil war broke out and it was decided that nothing could be done at the time for active conservation of the rhinos in Sudan.

Conservation efforts *in situ* were concentrated on Garamba National Park in Zaïre, which borders on to Sudan, where the remaining 15 rhinos were successfully protected in the context of the whole ecosystem of the park. In eight years the population had doubled.

In 1983 there were 12 northern white rhinos in captivity. In 1995, there are 9 pure bred and one which is a cross between northern and southern (*C.s.simum*) . They are in 2 groups: 2 males and 2 females in the San Diego Wild Animal Park, USA: and 2 males and 3 females in the Vychodeceska Zoo in Dvur Kralove, Czech Republic. During the period 1984-1995, only 1 female has bred and she has since died.

Following meetings with the Director of the Institut Zaïrois pour la Conservation de la Nature (IZCN) and representatives of IUCN, WWF and the International Rhino Foundation (IRF), and meetings of the IUCN African Rhino Specialist Group (AfRSG) in May 1994, it has been agreed that a strategy should be developed and implemented to consider the world wide population of this endangered sub-species as a whole metapopulation in conservation and management activities, in order to ensure its continued survival.

Various reports have been received recently of rhinos having been seen in different parts of Southern Sudan. If they are true, any northern white rhinos remaining in Sudan could constitute a significant proportion of a total world population, since the confirmed animals at present number 37.

OBJECTIVES

- To carry out surveys in southern Sudan to confirm or refute the presence of any remaining northern white rhinos.

- To assess possibilities for their conservation and to submit informed recommendations in this regard.

JUSTIFICATION

- There are only 37 confirmed northern white rhinos remaining alive in the world. If any still exist in Sudan they would make a significant contribution to the world population.

- It has been recommended by the African Rhino Specialist Group of IUCN that the sub-species be managed as a metapopulation to ensure its survival. The numerical and genetic contribution of a sub-population in Sudan would be important in this regard.

- In view of the above a project to survey the remaining rhinos in Sudan has been identified as a priority by the IUCN AfRSG.

METHODS

Two regions have been selected for investigation, based on the validity of reports received and knowledge of the areas in question. These are Southern National Park, which is considered first priority, and the Pakkam region.

In each area an aerial and a ground survey is proposed. All investigations will be carried out with full knowledge of and in collaboration with wildlife officials in southern Sudan, local authorities and international aid organizations operating in the region, under the auspices of Operation Lifeline Sudan (OLS). Knowledgeable local observers will be used as guides. Investigation period is limited to the dry and early wet seasons, i.e. the first half of the year.

Ground Surveys

The ground surveys will be carried out by two investigators with a local guide, using mountain bikes. Mountain bikes will allow better coverage in rough terrain within the time available and facilitate carrying enough equipment to be self sufficient for up to a month at a time. The following approaches will be used:

- Following up any reports of sightings or indications of rhinos
- Focus during the dry season on sources of water, following rivers and investigating water holes
- Investigation of areas of suitable habitat identified during the aerial surveys
- Counting any signs of rhinos, and other species per unit distance walked/ridden (Hillman 1983), in order to relate to known densities elsewhere
- Following any signs of rhinos to attempt to obtain direct sightings and to maximize information indicating numbers or densities in a region.

Aerial Surveys

It is proposed that aerial surveys are carried out using the Cessna 206 of the Garamba National Park Project, which belongs to the Frankfurt Zoological Society (FZS).

- Crew of six including pilot and the ground investigators
- Low intensity systematic reconnaissance flight (SRF, Norton Griffiths 1978) over the whole region, followed by
- intensive coverage of regions identified as potentially possible for rhinos.

Southern National Park

To survey Southern National Park the aircraft would refuel in the north of Garamba National Park from fuel transported there with the GNP vehicle. Logistical base within Sudan for this region would be Mapel, a relief airstrip north of SNP.

To survey the Pakkam region, fuel would be flown in collaboration with aid aircraft. There are airstrips at Maper and Mariel to the west of Pakkam.

Clearances

Clearances to carry out the surveys have been received verbally from the SPLA authorities, which control the area. OLS and relevant aid organizations are being requested to co-operate. OLS, for example provide security cover for relief workers in South Sudan, and might extend this, through the radio network, to survey members. Clearance is being sought from IZCN and FZS for collaboration of IZCN observers and for use of the aircraft.

Timing		**1996**
Preliminary ground surveys,	Southern National Park	February
	Pakkam	February/March
Aerial Survey,	Southern National Park, Pakkam	March/April
Follow up ground surveys,	Southern National Park	April/May
	Pakkam	May/June
Reports	July	

OUTPUTS

Reports of activities and findings will be produced by end July 1996. This will be followed up by discussions and a feasibility report on conservation possibilities if any signs of rhinos are found.

BUDGET

Capital Equipment	£ Sterling
Mountain bikes x 3 @ £500 ea	1,500
Tools	50
Spare tyres	120
Pannier racks and bags	135
Bottles & cages	40
Inner tubes (x 8)	45
Puncture repair kits	25
Spare brake wire	10
Lights (dynamo)	150
Tents x 3 *	600
Sleeping bags	160
Water filter (Katadyn)	100
Compass *	30
Binoculars *	250
Rucksacks *	75
Cooking equipment	20
Radios *	
Recurrent costs	
Air fares London-Nbi return x 2	1000
Nairobi-Sudan rtn x 2	400
Living expenses x 2	2000
Medical insurance x 2	500
Medical kit	50
Film	100
Visas	200
Contingencies	200
Flying time 40 hrs @ $300	8000
Fuel transport	500
TOTAL	**£ 16,070**
	US$ 25,712

* Denotes items that may be borrowed from the Garamba National Park Project
As far as possible other capital items will be requested on donation

9. OFFICIAL MINUTES/REPORTS OF STRATEGY MEETINGS 1994

IUCN/SSC AFRICAN RHINO SPECIALIST GROUP MEETING ON NORTHERN WHITE RHINO GLAND SWITZERLAND - 8 MARCH 1994

Participants: *Martin Brooks (Chair), Mankoto ma Mbaelele, Nzau Kunkemba, Sivi Dia Yamba, Nsuka Simon, Pete Morkel, Mbanga Manzimi, Tom McShane, Muhindo Mesi, John Newby, Kes Smith, Simon Stuart, Tom Foose (Recorder).*

MINUTES

Introduction

The Chair opened the meeting and welcomed all participants. He described the situation of the northern white rhino as being extremely critical, with fewer than 50 rhinos in the wild and in captivity combined. It has been suggested that to maintain the entire wild population in a single location is risky. It is clear that authority for the wild rhino resides with the government of Zaïre. It is their decision what to do. The purpose of this meeting was to explore options to determine if this group advises continuing on the same course or trying some alternative approaches. The Chair explained that the role of the SSC African Rhino Specialist Group (AfRSP) is to provide information and advice to African nations for management of rhino.

Objective of the Meeting

The Chair proposed the following objective for the meeting:

To examine the situation in Garamba and recommend a plan of action for the long-term survival of the subspecies, also considering the rhino in captivity and perhaps elsewhere in the wild.

This objective was agreed by the meeting.

J. Newby stated that the feasibility of translocation should be evaluated closely. K. Smith thought that translocation should be considered as part of a more holistic plan for the subspecies. The Chair stated that the meeting would consider the different management options. T. Foose thought that the meeting should review risks first, then options.

The Status of the Subspecies in the Wild

K. Smith reviewed the situation in Garamba. The project focuses on *in situ* conservation of rhinos as part of the Garamba ecosystem. Protection and management of the rhino population since 1984 has resulted in an increase of 7% per year. There are now 33 animals as far as known, although three individuals were not observed during 1993. However, not all areas were exhaustively surveyed during 1993. During 1993, three births and two deaths were recorded. There is no doubt that Garamba provides excellent habitat for the northern white rhino.

General wildlife poaching has increased since 1991. In this year, there was a refugee influx from Sudan, and a considerable number of firearms were recovered. In 1993, elephant poaching increased and as a result, anti-poaching efforts have been enhanced. The quality of life for the guards is not good at present. Money from WWF and others has helped, though has not made good the hole resulting from

the withdrawal of most of the support previously given by the Frankfurt Zoological Society. Dr. Smith felt that the pros and cons of translocation had to be considered in relation to other possibilities, and also in relation to the availability of external funds. Although there have been some problems, she was confident that if adequate resources are available, the project can continue to protect and manage the rhinos as well.

S. Stuart pointed out that the AfRSG has identified *in situ* conservation of Garamba rhino as the highest priority in Africa. It was important to realize that translocation options would not diminish the need or priority to continue the Garamba project, and to strengthen the protection of the rhinos.

Dr. Smith also referred to the persistent reports of rhino in Southern National Park in Sudan, but there was still no verification of this.

Dr. Mankoto expressed his thanks and deep appreciation to the Garamba team and to the donors who had assisted over the years: WWF, FZS, UNESCO and IUCN. He reminded the meeting that IUCN had previously proposed translocation of the rhinos in 1985. This was not well received at the time in part because the *in situ* programme had only just commenced. We now know that this programme has been successful. However, since 1985 the political situation in Zaïre and neighboring countries has deteriorated. So there is now a greater willingness to consider translocation as part of a holistic strategy. Any proposal would have to be very cogent, conceptually sound and technically feasible. It would also need to be presented by a high-level delegation visiting Zaïre. He thought that such a high-level mission might cover issues in Virunga as well as Garamba.

Dr. Mankoto referred to a one-time grant of Japanese funding for Garamba that had been channelled through the World Bank. The Chair requested Dr. Mankoto to comment on the security situation around Garamba. He responded that the situation had clearly deteriorated, and was much worse than in 1985. The civil war in Sudan was a constant threat, and the political future in Zaïre remained unclear. He again emphasized the need for an international mission to gain support from the highest political leaders for the Garamba project.

Dr. Mankoto inquired about genetic problems that could result in the Garamba population. The Chair responded that inbreeding would probably not be a major problem if he Garamba population continued to expand rapidly. Dr. Smith stated that until recently there were equal numbers of males and females with at least 6 males participating in reproduction.

The Chair asked the meeting to consider the risks of having all rhino in one place. These were listed as follows:

* natural disasters
* epidemic disease
* civil disorder
* breakdown of the protection system

The Chair reminded participants that it was not the purpose of this meeting to develop a detailed plan, but rather to determine whether or not there is a common direction agreed by all the parties represented at the meeting.

The Status of the Subspecies in Captivity

T. Foose summarized situation in captivity. There were 9 rhino (4 males 5 females) in captivity in 2 facilities: San Diego in U.S.A. and Dvur Kralove in the Czech Republic. There has been no breeding in San Diego, and limited reproduction at Dvur Kralove (last young born in 1989, though one female

is possibly pregnant). He did not agree with suggestions that the two females in San Diego were too old to breed, southern white rhino females having bred at older ages. There were problems with the current captive management, though he thought that some of the current difficulties could be overcome.

When asked if the two zoos would be prepared to give up their animals, Dr. Foose thought that they would be if a coherent strategy for the subspecies could be developed and concerted and unified efforts were directed towards encouraging the two institutions make their animals available for the strategy. He noted that all but one of the animals are the property of Dvur Kralove Zoo.

Dr. Foose also mentioned that rumors persist that there may be 5 subadult rhino for sale in Khartoum @ $120,000 FOB Khartoum. These rhinos are supposedly wild-caught and have the necessary papers for legal export. He was still trying to ascertain more information of the circumstances.

Management Options

The meeting identified the following options that are available for the future conservation of the subspecies. Note that not all the options listed below are mutually exclusive.

(1). Abandon the Garamba project.

(2). Secure the Garamba programme.

- (A) No removal of animals
- (B) Removal of some animals

(3). Relocate rhinos to captivity:

- (A) All animals
- (B) Some animals

(4). Relocate rhino to the wild or free-ranging situation in a natural or quasi-natural situation.

- (A) All animals
- (B) Some animals
  - (a) Africa
  - (b) Elsewhere (North America; Australia).

(5). Contingency plans in case of emergency

The meeting decided that the following options could be ruled out as being undesirable, or likely to be ineffective: 1 (Abandon Garamba project): 3A & B (Relocate animals to captivity); 4A (Relocate all Garamba rhino to the wild or free-ranging situation in a natural or quasi-natural situation).

Concerning option 2, discussion took place on the security of the Garamba population, and the feasibility of translocating animals. As regards the security of the Garamba population, it was asked if it is possible to ensure the complete safety of rhinos. It is obviously not possible to guarantee the safety of the Garamba rhinos (or any other rhino population). However, the project has been very

successful so far. The main concerns for the future include the following risks that are hard to quantify: incursions from abroad; breakdown of civil order; organized commercial poaching. Mr. Muhindo stated that although there has been some elephant poaching, this is not considered to present a risk to the rhino.

Concerning the feasibility of translocating animals, P. Morkel stated that this would be possible, but expensive and extremely difficult logistically. The set-up costs for a translocation programme would be very high. The amount that would need to be spent to move the first animals would be US $500,000 (about 1/3 of the cost is transport as far as Kenya). There are risks, and about 5% of the animals moved would not survive. The operation would have to occur during the dry season. There would need to be a 6-12 month preparation phase. Probably a maximum of 10 rhino could be moved per season. After the first animal, the cost per animal would be mush less.

N. Kunkemba asked if the large amount of money for translocation could be better spent protecting Garamba. T. Foose responded that money that would be available for translocation programmes probably would be earmarked and could not be transferred to protection of rhinos in Garamba. Dr. Mankoto emphasized that it was not desirable to remove all rhino from Garamba, in large part because the rhino are the flagships for Garamba (and moving all the rhino would present problems with Garamba's status as a World Heritage Site). If some translocation takes place, what benefits would there be to the National Park? And what guarantees would there be that rhino would be returned for re-introduction at an appropriate time in the future? And what about ownership? Dr. Mankoto considered it essential that rhinos remain the property of Zaïre. T, Foose stated that there are already three other rhino programmes (black rhino form Zimbabwe and Natal, and Sumatran rhino from Indonesia) which address satisfactorily the questions raised by Dr. Mankoto concerning returning financial benefits to protected areas, providing animals for re-introduction and retaining ownership with the country of origin. Such agreements were more likely to be negotiable if animals are moved to a free-ranging situation outside the African continent (since very few institutions in Africa would be able to provide the necessary financial resources to Garamba).

The meeting concluded that the option of translocating some of the rhino outside Garamba (essentially options 2B and 4B) was a possibility that required further investigation. However, the issue still remained as to whether animals taken out of Garamba should be sent to another site in Africa, or to sites outside Africa altogether. In order to consider this point, the meeting identified the criteria that should be satisfied by any receiving site:

* High Security
* High Habitat Suitability
* Carrying Capacity of 20+
* Cost Effectiveness (infrastructure in place)
* Proximity to Garamba (to facilitate metapopulation management)

K. Smith mentioned that there had been some suggestions to move animals to Uganda; this would be desirable in terms of restoration of rhino to natural range but would be very expensive since infrastructure is not in place. Dr. Mankoto asked if there were other places in Zaïre itself where criteria for a receiving site could be satisfied, for example, the Virunga national Park. Dr. Smith felt that although there would be some advantages in this, it would still be very expensive. Also many of the problems of Garamba relate to the situation in Zaïre itself, and these would apply to Virunga as well. The Chair emphasized the importance of the site being financially self-supporting so that not much money will be needed for maintenance. P. Morkel said that it was desirable that the new site not only entailed low cost but also generated revenue for Garamba. This could be achieved if all rhino currently in captivity could be moved to a free-ranging location in the United States, and supplemented by a few rhino from Garamba, thereby generating money for Garamba. S. Stuart stated Zaïre would

need to decide if it was prepared to allow animals to go outside Africa. Dr. Mankoto responded that such a decision would depend on the pros and cons of the different options. There was no *a priori* reasons to reject out-of-Africa options. If security is the paramount concern, then out-of-Africa options could be important.

Concerning contingency plans, the meeting felt that these should focus on moving extremely tight security rapidly into the area when a pre-determined state is reached. Dr. Mankoto said that it might be possible to call on well-trained paramilitary under an emergency situation.
The meeting felt that an emergency evacuation of animals would probably not be possible. This would probably result in a 40-50% mortality.

Revised Management Options

As a result of these discussions, the management options were reduced to the following:

(1). Garamba *in situ* conservation - no relocation of rhino

(2). Garamba *in situ* conservation - some relocation of animals

(A) Africa

(B) Elsewhere

(3). Integrated-Coordinated Programme

(A) Population in Garamba and another elsewhere in Africa (new population could include some captive animals)

(B) Population in Garamba and one outside of Africa (consisting mostly of existing captive animals supplemented by a few from Garamba)

(4) Contingency

Quick paramilitary response from within Zaïre to secure the Garamba population.

Note that options 2 and 3 are very similar. Drs. Brooks, Morkel, Foose agreed that 3 males and 3 females would be the minimum nucleus for starting a new population. Dr. Morkel stated that translocation of rhino from Garamba would probably require 2-3 years to accomplish.

The meeting agreed that continued conservation efforts would be needed in Garamba whatever happened, and also that a contingency plan should be drawn up. It was agreed that a working group should be established to examine the pros and cons of the remaining options involving translocation of animals.

After some discussion, the meeting agreed on the following approach:

(1) A Working Group should be formed

(2) The Working Group should prepare recommendations in a draft report

(3) Workshop in conjunction with AfRSG Meeting in Mombasa (May)

(4) Workshop in Zaïre

(5) Preparation of final report

(6) High-level mission to Zaïre

(7) Decision by Zaïre

The meeting agreed that K. Smith should act as Convener of the Working Group. Members should include P. Morkel, T. Foose, Dr. Mbayma, Muhindo Mesi, and R. Brett. The meeting also agreed the aspects that should be considered by the Working Group in its report:

- Ownership of animals/legal arrangements
- Candidate sites that satisfy the criteria
- Linkage of sites to support for Garamba
- Population consequences for Garamba and the receiving site
- Involvement of captive animals
- Costs of everything (including *in situ* conservation in Garamba as well as for possible new populations.)

The draft document should describe all options, costs and benefits in order to evaluate their pros and cons. It should conclude with a recommendation for a particular option.

J. Newby asked if the meeting endorsed the idea of establishing a second population. The Chair responded that the meeting did believe there are sound reasons for relocation of some rhino from Garamba to establish one or more free-ranging populations and is therefore mandating a working group to develop the details for such options.

Immediate Actions Needed for Programme in Garamba

K. Smith outlined the urgent need to support Garamba at a higher level than now exists, especially for anti-poaching. There is also a need to ensure that the project provides benefits to local people. There is an immediate need to:

- Improve conditions for the guards (housing, pensions, etc)
- Increase salaries and security
- Recruit additional guards
- Provide for promotions
- New equipment for guards
- Community extension work to develop popular support to help protect rhino

Dr. Mankoto responded that IZCN faces a severe funding crisis, due to the very rapid inflation in Zaïre. He recognized the problems outlined by Dr. Smith and was currently carrying out hard negotiations with the government. He was hopeful of improvements, but could not yet say anything for certain.

J. Newby said that WWF would appreciate greater attempts at fund-raising for Garamba. Over the short-term, WWF will not be able to increase and may have to decrease support for Garamba. K. Smith referred to the possibility of a Trust Fund. S. Stuart drew attention to the major problem of many international donors withdrawing from Zaïre. He suggested UNDP as a possibility, as well as some consumer countries like Taiwan. The GEF would be a long-term possibility, as regards a trust fund endowment for Garamba. K. Smith stated that Garamba needs $300,000 per year now; $400,000 if the community extension work is included. WWF is currently providing about $200,000. J. Newby

said that it was imperative that there be a good funding document as soon as possible. T. Foose mentioned that the adopt-a-park concept being developed by the captive conservation community.

Conclusion

The Chair summarized the achievement of the meeting as follows:

- Identified sound conservation reasons to relocated rhino from Garamba
- Explored the possibility of establishing a second population, possibly in conjunction with rhino from captive community
- A detailed assessment of options will be prepared by the Working Group led by K. Smith
- Agreement that tangible benefits must accrue to Garamba as a result of any relocation project
- Once agreement has been developed on a strategy, then a high-level mission visit Zaïre
- New funding possibilities for Garamba have been identified

He thanked all participants for their contributions to the meeting, which he felt, had made significant headway in developing a holistic strategy for the conservation of the northern white rhino.

REPORT OF NORTHERN WHITE RHINO WORKING GROUP IUCN/SSC AFRICAN RHINO SPECIALIST GROUP (AFRSG) MEETING MOMBASA, KENYA 23-27 MAY 1994

Participants: *Mbayma Atalia, Kes Smith, Nigel Leader Williams, Mark Stanley Price, Pete Morkel, Raoul du Toit, Tom Foose*

GOAL

To ensure the survival of the northern white rhino with emphasis on wild populations.

SUMMARY OF MAJOR ACTIONS PROPOSED BY AfRSG

- Metapopulation management, including consolidation of zoo groups
- Workshop of stake-holders to agree approach, preferably in Garamba
- Provision of adequate support for *in situ* conservation in Garamba
- Formulation of a contingency plan for Garamba

CURRENT STATUS

1. There is one known wild population, currently of 28 confirmed and 4 possible northern white rhinos in its natural habitat, that has bred up successfully at a high rate of increase since 1984 in Garamba National Park, Zaïre.

2. This population is below carrying capacity, but is at potential risk from poaching, trans-border incursions and possible civil unrest.

3. This population is a key element of a World Heritage Site that has been largely dependent on donor support.

4. An unknown number of rhinos may exist in natural habitat in Sudan.

5. Two groups exist in zoos in the Czech Republic and USA, numbering 5 and 4 respectively, which represent 25% of the world population.

6. The zoo population has declined since 1984 from 12 to the present 9, with deaths exceeding births.

7. Despite the small size of the global population, none of the different groups of rhinos are in breeding contact, or part of an inclusive and integrated management programme linking wild to captive animals.

OBJECTIVES

1. To establish an integrated management programme that aims to maximize the rate of increase of the global population as rapidly as possible.

2. To spread risk to the global population by ensuring, in the short term, that a second group breeds successfully in a second country.

3. To ensure that the Garamba population is not put at risk from any actions arising from the integrated management programme.

4. To ensure an effective level of support for the maintenance of the *in situ* population at Garamba.

5. To draw up a multi-faceted contingency plan to be implemented in the event of an emergency at Garamba.

6. To confirm or otherwise the existence and location of any rhinos in Sudan and to ensure their integration into the metapopulation.

FUNDAMENTAL TECHNICAL REQUIREMENTS

1. It is necessary to manage all rhinos in an integrated plan according to metapopulation principles. This will require optimizing social structure, and ensuring the reproductive activity in a manner that brings the global population out of a bottleneck as rapidly as possible and in a way that minimizes loss in genetic diversity.
2. It is necessary that all rhinos presently kept ex situ be in ecological and social conditions that are free range and most closely resemble those in their present natural habitat.
3. It is necessary to ensure that all management decisions are made against a set of a priori performance criteria agreed by all stake-holders.
4. It is necessary to ensure that all movement to a new site does not reduce the viability of the source population to an unacceptable extent unless i. that population is already inviable for other reasons or ii. it has been decided to reduce the source population for other reasons.
5. It is essential that when any new population is established, certain minimum standards must be met including suitability of the area, adequacy of security, numbers and composition of founders, extent to which they can be managed under metapopulation principles, and their genetic representation.
6. It is necessary to recognize the biological value of the rhino in Garamba and other natural ecosystems and the importance of the species as a flagship.
7. Ultimately it is necessary that further wild populations are established.
8. It is essential that one aim of metapopulation management is to provide rhinos for release into former natural range, giving preference to donor areas.
9. Translocations will be undertaken according to the highest technical standards

POLITICAL AND ECONOMIC CONSIDERATIONS

The following are important issues that AfRSG is not fully in a position to answer, but that AfRSG wishes to flag as fundamental issues to be addressed by stakeholders.

1. Ownership animals and progeny
2. Selection of ex situ countries and sites
3. Management control of the metapopulation
4. Assistance for implementing the contingency plan
5. Funding of *in situ* conservation in Garamba
6. Funding of consolidation of the ex situ population
7. Funding of contingency plan
8. Funding of capture, translocation and release
9. Funding of any re-introduction
10. Interactions and conditionalities relating to funding, due to donor interests and priorities.

An important component to secure the future management of the northern white rhino is the identification of key stake-holders. Certain stakeholders can be identified with ease, but others will depend upon an approach and an expression of interest for their future involvement, for example particular donors, or possible areas for releasing rhinos.

RECOMMENDATIONS FROM THE AFRICAN RHINO SPECIALIST GROUP
May 1994

It is imperative for the survival of the taxon that as many rhinos as possible, currently living either in the small wild population or genetically isolated or non breeding groups, or as scattered individuals, are managed as members of a metapopulation. Accordingly, AfRSG recommends that IUCN, the Government of Zaïre, and the global captive conservation community, takes immediate steps to implement the following actions:

1. AfRSG recommends that the report entitled "The strategies for the conservation of the northern white rhino" arising from the WWF/SSC meeting in Switzerland in March 1994 is completed by August 1994.

2. It is recommended that a proposal for a major meeting of stakeholders in the survival of the taxon be developed and agreed as soon possible. This would have the purpose of designing, planning and financing a detailed and pragmatic action plan for the taxon as a metapopulation, for the immediate and medium term. This meeting should preferably take place in Garamba, but not if this is to the detriment of full attendance by stakeholders. Planning for the workshop should aim to achieve its organization in January 1995.

3. AfRSG sees consolidation of the present captive population into conditions and management regimes conducive to successful breeding, as a likely outcome of the workshop, and as a probably essential first step in achieving the goal of metapopulation management. This would also be an indicator of the will of relevant parties to conservation of the taxon.

4. Recognizing that Garamba holds most of the world population in natural habitat, as well as the intrinsic biological value of the park, an immediate priority is to ensure that adequate support is provided to Garamba to protect the population against poaching and other threats. This priority should be noted as one of immediate importance given that other actions will not occur immediately.

5. In view of the risks from a possible increase in poaching pressure and the potential for civil unrest, it is recommended that a contingency plan for the enhanced protection and/or evacuation of the rhinos be formulated, and all aspects of its implementation be guaranteed. A draft of this plan should be developed alongside the report from the workshop in Switzerland, and be completed by August 1994.

TECHNICAL DECISIONS TO BE CONSIDERED BY STAKEHOLDERS

As per previous.

GARAMBA-NORTHERN WHITE RHINO MEETING

WWF OFFICES
NAIROBI, KENYA 12 OCTOBER 1994

MINUTES

Participants: *Martin Brooks, Fraser Smith, Kes Smith, Holly Dublin, Mark Stanley Price, Tom Foose*

Brooks Reviews history. Early 1980's proposals for translocation considered rejected. Consideration resumed in March 1994 at meeting at IUCN Headquarters in Gland, Switzerland. Objective was to explore improved options for conservation of rhino. At that meeting, Mankoto advised that situation in Zaïre had deteriorated and the country was now ready to consider translocation as part of holistic strategy. Number of management options

(1) No relocation of rhino - concentrate on Garamba.
(2) Concentrate on Garamba but with some relocation in Africa or elsewhere.
(3) Integrated metapopulation management perhaps involving captive population.
(4) Contingency plan for Garamba.

Meeting concluded that were sufficient reasons to consider relocation. That a more detailed plan would be developed. Garamba would remain the highest priority.

Working Group formed with Kes as leader with task of producing report with elaboration and evaluation of all options with recommendation of preferred in time for Mombasa meeting.

Then there would be a meeting in Zaïre to get consensus. Concurrently, should be an approach to Mobutu.

Mombasa meeting in May 1994 re-endorsed metapopulation management option (i.e. 3 from Gland). Reiterated that a draft document needed to be finalized. To a large extent, Mombasa was an extension of the Gland meeting but did not proceed much further because the document was not done.

Kes Thought that assignment from Gland/Mombasa was a background document for a workshop at which strategy would be formulated. Had assigned various persons to prepare components of the report. Most only arrived at Mombasa with them. Now has a further draft, which she presents.

Brooks Purpose of this meeting is to determine what we have and where we are and how do proceed with a workshop. How adequate is content of current draft report. If needs improvement, how to we do and by when. Mentions that now there is a WWF decision that further development of report should be assigned to Holly Dublin and Tom Foose.

Kes — Thought that the document she was preparing was to present options to be discussed at future workshop rather than arriving at preferred courses of action in advance.

Brooks — Could we commence with discussion of what has changed since Mombasa.

Fraser — Surveys indicate a definite 29 rhino. In June poaching attained worst level ever. Used hand grenades but in north, not where rhinos are. Garamba Project used military to contend with poachers. After very active 2 weeks in June, poaching no longer out of control. Situation back to previous situation. Just a few groups a week. Gratifying to observe how rapidly situation could be placed under controlled. Now have support of fairly high general as had been case before.

Price — How long can you play the military card.

Fraser — Have been using the military for 4 months. Incentive has been the premiums paid. No money for it now.

Holly — Have employed same deployment of military in Mara. Worked well at first. But now has deteriorated with military in complicity with the local poachers.

Fraser — Agrees is a risk. Reason don't have military there permanently: in two weeks; out two weeks. Need to get support from uppermost levels. Optimum would be 20 elite military guards, not just locals. Initially used 30 military. Now down to 15-20 military.

Brooks — Can we review report to determine how it needs to be modified to serve as the basis for the workshop. Did Mombasa conclude that a preferred option should be in report?

A lot of discussion of how much recommendation or conclusion should be in the report.

Brooks — In general, the report should provide a flow of logic on all options and subsequently a strong indication of a recommended strategy.

Holly — Is danger that if incorporate too much detail, Zaïrois may think others deciding things without their involvement. Think Mankoto should be advised of what is happening.

Brooks — Would like report submitted to AfRSG (at least Brooks, Brett, etc.)

Does the report submitted by Kes need to be refined further.

The report needs to have a separate section delineating each option with all costs/benefits.

Report should contain:
- Each option in detail;

- Costs; funding sources; technical feasibility; time lines; anticipated contingencies.
- Must be logic flow that directs toward certain option(s) over others.
- When considering option, some have more costs than others. It would be optimal if can identify and select options that will not incur additional costs to global conservation community. So if establish new population in new country must have options that would not require additional costs.

Price Uganda would be a high cost place Uganda was originally in full range of species.

Brooks Credibility a problem too. Uganda doesn't have a good record. Must be very careful.

Price Now must work through the details of these 4 options. Must try to project what contingencies will occur and how management would adapt.

Brooks Must determine what will be most sustainable. Garamba must be more self-sufficient and long term sustainable.

Foose Discusses approach from UNDP GEF. Received call from John Hough at UNDP New York. He indicated that Zaïre had submitted proposal for GEF project encompassing Garamba, Ituri and IZCN. He was interested in exploring de-linking the 3 components and pursuing the Garamba on a faster track. Indicated that there could be money for a preparatory Assistance Mission to help develop strategy for Garamba and perhaps support proposed workshop.

Holly There are two approaches that include funding for Garamba. One is to the World Bank from WWF and is exclusively for Garamba. World Bank proposal includes discussion of a Trust Fund. The other is to UNDP-GEF and incorporates Garamba, Ituri, and support to IZCN.

UNDP and World Bank must have different but complementary roles.

Brooks Next thing to consider is workshop.

What are objectives.

Will commence with a very detailed report.

Goal Consider management options and adopt one or more at a fairly senior IZCN level.

Price Goal: Initiate action on integrated activities for northern white rhino

Aims: (1) Assemble the key players in northern white rhino conservation with such experts on southern white rhino.
(2) Adopt a widely accepted conservation strategy.
(3) Define commitment to ensure action and implementation.

Organizers must have a common vision of who should and should not be at meeting.

Brooks — First develop timetable for report.

Price — Workshop needs facilitators and possibly other experts (e.g., decision analysis).

Brooks — Zaïre are ultimate deciders on wild population; global captive community and holding institutions on the captive population. Want to elicit as much support from captive community for both metapopulation management and support of *in situ*. Development of the ex situ programs should not negatively impact program in Zaïre.

So what is time line on report.

Kes — Should site visits be included.

Price — Do we have to relocate rhino to area within historic range. If goal is to increase numbers of rhino to get through the demographic bottleneck, then the criteria for selecting site may be different.

Different options will have different costs and different sources for funds.

Brooks — 30 April as deadline for report. Workshop proposed for July-August.

Kes — Is Garamba the site? Advantage is for everyone to see.

Price — Need high powered people. Must minimize time. Simultaneous English and French translation.

Foose — Can do field trips before and/or after. (Mankoto might rendezvous with them there).

Brooks — Assign Foose to investigate venues and consequences of workshop site. Also of pre-workshop visit. Possible venues include: Nairobi, White Oak.

Fraser — Charter aircraft. (Late April through May optimal for Garamba visit).

Brooks — Should Mankoto be consulted to determine if he agrees to workshop not being in Zaïre.

Brooks — Decide AfRSG leader of initiative; hence organizer of workshop; writer of letter.

Letter to Mankoto to describe what has to be done in preparation of workshop. Should include a contingency plan. Also the letter to all key players.

Brooks Tentative List of Workshop Participants:

IZCN: Director + 3 other from higher levels Govt.
Garamba: Mbayma Atalia, Muhindo Mesi, Fraser and Kes Smith
AsRSG: Brooks, Emslie, Leader-Williams, Morkel
NGOs:
WWF: Holly Dublin, J. P. d'Huart
AWF: Mark Stanley Price
IRF: Tom Foose, John Lukas
SSC: Simon Stuart, George Rabb
Zoos: 2 San Diego, 2 Dvur Kralove, 2 Columbus, Reece
GEF: John Hough (UNDP) and World Bank

Potential Relocation Countries (4 Individuals total):
Kenya:
Uganda:
South Africa:

Facilitators: Possibilities include: Lynn Maguire, Hassan Moinuddin

2 or 3 Translators/Technicians

2 Secretary

Workshop should be 2 Intensive Days with people arriving the night before.

Price Is it possible to identify risks to individual rhino. Need more detailed modelling in terms of demographics, dynamics, genetics. Need to model different relocation sites.

Kes Will get with Foose to discuss more detail on individuals for modelling.

Price/Kes Some discussion of possibility of surveying in Sudan

Foose Have everyone at this meeting read Kes' report and circulate comments to all at this meeting.

Price What about a contingency plan. Need stages and triggers.

Brooks Is contingency for crisis appropriately part of the metapopulation plan. Perhaps need as separate item.

Fraser Need presidential support to deploy elite units (Beret Rogue) if crisis really intensifies.

Brooks Believes it is incumbent upon Conservation Team in Garamba to develop a contingency plan and that it should be considered separate from the longer-term metapopulation plan.

Foose Disagrees.

Holly	Really need someone who is dedicated to development of contingency plan.
	Need specifics. Need to decide what are options/what aren't. May need some one dedicated for awhile.
Brooks	Need plan of what needs to be done. But also need to identify who will do what if plan needs to be activated.
Holly	Need coordinator for contingency plan. WWF could do but needs mandate.
Brooks	Need to refine contingency plan and arrange who would do what when. Need to proceed to try to contact Mobutu. Also should be placed in a letter to Mankoto. Approach to Mobutu must precede further attempts at arranging details for implementing contingency plan if needed.
Holly	Participants in this workshop should provide input to Kes on the contingency plan part.
Foose	Letter to Mankoto from Martin Brooks to be composed by Holly and Tom.
Kes	d'Huart has already drafted letter but also don't know if it has gone.
Price	What if GEF doesn't fund workshop.
Foose	Then will have to explore alternatives. There are some, e.g. some support from IRF, British Airways, etc.

Brooks: **Recapitulation:**

Holly and Tom will prepare report assessing the various management options for long-term conservation of rhino considering all the pros and cons and searching for programmatic cost-effective options.
Completion date: *30 April 1995. Foose will try to prepare first rough draft for review with Holly at CITES meeting.*

Kes will revise contingency plan with input received from participants in this meeting.
Completion date: *Before Kes returns to Garamba in early November.*

Holly and Tom to prepare draft of letter to Mankoto describing what is occurring for signature by Brooks and translation by d'Huart. It should include reference to development of a contingency plan.

A similar letter will go to key players from Brooks. Again Holly and Tom to prepare. Don't discuss contingency plan in this letter.

Conduct a 2 day workshop of key players at end of July or August-September. A preliminary list of players has been identified. Option of a pre-workshop visit to Garamba in latter half of April of in May to Garamba. Should go in letter to key players. Fraser will obtain estimate of costs.

Foose will explore venues for workshop and return with recommendation to AfRSG Chair and WWF. Suggestions will include statement of aims.
Aims: (1) Assemble the key players in northern white rhino conservation with such experts on southern white rhino.
(2) Adopt a widely accepted conservation strategy.
(3) Define commitment to ensure action and implementation.
A provisional list of participants should also be included.
Completion date: *By end of year.*

Holly and Tom will liaise with John Hough about possible GEF funding of workshop and strategy development process.

10. A. POPULATION SIMULATIONS USING VORTEX*
GARAMBA POPULATION
NORTHERN WHITE RHINO

SCENARIOS INVESTIGATED & INPUT PARAMETERS USED

All simulations have been performed with 500 runs.

BASIC SCENARIOS (6 Scenarios):

Basic parameters used for the simulations are:

- **Initial Population = 28 (14.14, i.e. 14 males and 14 females)**

  This population represents the confirmed individuals as of May 1995.

- **Age at First Reproduction = 7 years for ♀♀; 10 years for ♂♂**

- **Age of Senescence = 37 years**

  (Based on Norman Owen Smith's data for Southern White Rhino for which fecundity declines rapidly after age 35 for females. Since some reproduction does continue until mean age of death at 40-44 years, a figure of 37 years has been used to allow for continued but reduced reproduction after age 35.

- **Reproduction:**
  Three levels of reproduction are considered in the basic scenarios:
  - 40% females producing in any 1 year = intercalf interval of 2.5 years
  - 30% females producing in any 1 year = intercalf interval of 3.3 years
  - 20% females producing in any 1 year = intercalf interval of 5.0 years

- **Natural Mortality Rates (%/year):**

- Infant ♀♀ and ♂♂ (Age Class 0-1)	10%
- Sub-Adult ♀♀ (Age Classes 1-2 to 6-7)	1% in each age class
- Sub-Adult ♂♂ (Age Classes 1-2 to 9-10)	1% in each age class
- Adult ♀♀ (Age > 7 years)	3%
- Adult ♂♂ (Age > 10 years)	3%

  These rates correspond to observed mortalities in the population.
  - Infant mortality of 10% ≈ 2-3 deaths out of 23-24 births during 1984-1995.
  - Adult mortality of 3% ≈ 1 death every 3-4 years for a population with ~ 12 adults as has been case for Garamba over last 11 years. This mortality rate also corresponds to the number of deaths relative to the average number at risk if the individuals not observed since 1992 are assumed to have died. These rates are slightly higher than reported by Norman Owen-Smith for Southern White Rhino where adult ♀ mortality was about 1.2% and adult male about 3.5%.

  The combination of the above mortality rates and 2.5 year intercalf interval produces an mean annual increase rate of 7% (i.e. λ = 1.07, r = .07) the observed value for 1984-1994.

- **Inbreeding:**

  In all simulations, **inbreeding** is considered operative because of the several bottlenecks of small size through which the population has passed in last 50 years and especially last 20 years. In the absence of any specific information on intensity of inbreeding, a level equivalent (3.14 lethal equivalents per diploid locus) to the average for over 50 species of mammals has been used.

- **Carrying Capacity:**

  A carrying capacity K = 200 Is used.

  Note: For those populations with a positive rate of change, the potential population at end of 25 and 50 years could be higher than ~ 200. A K of 200 was used (1) to expedite simulations (2) to acknowledge that an IPZ or sanctuary with 200 rhino is an objective with modest but perhaps feasible ambition.

CATASTROPHE (POACHING) SCENARIOS (12 Scenarios):

For each of the basic scenarios, the effects of **catastrophes** in the form of poaching are examined. In the model, a catastrophe is defined by a **frequency**, i.e. how often it occurs, and a **severity**, i.e. what its effect (increasing mortality, reducing reproduction) is on the population. All combinations of the basic scenarios with 4 levels of poaching are investigated:

- **Moderate Episodic Poaching** which occurs every **10 years** and **removes 25%** of the population.

- **Severe Episodic Poaching** which occurs every **15 years** and **removes 50%** of the population. The frequency of this level approximates what has occurred in Garamba in the last 30 years. However, the **severity** investigated is appreciably less than what has actually occurred.

- **Continuous (i.e. Every Year) Poaching** at two intensities:

  - **3.5% of the population is removed**, i.e. equivalent to the loss of about 1 animal every year at current population size.

  - **7% of the population is removed**, i.e. equivalent to the loss of about 2 animals each year at current population size.

No other catastrophes such as epidemic disease or environmental disaster have been investigated at this time.

* VORTEX is software developed by Robert C. Lacy, Ph.D. of the Chicago Zoological Society with assistance from Kimberly A. Hughes and Philip S. Miler to permit stochastic simulation of extinction processes operating on populations.

REMOVALS FOR RELOCATION TO A SECOND POPULATION (45 Scenarios):

A number of scenarios representing all of the above ones but this time involving removal of rhino from Garamba for relocation to another population are examined:

- Removal of Only Males
  - All Adult
- Removal of Males and Females at Two Levels (2.2 and 3.3):
  - Adults and Subadults

For these simulations, it is presumed that all rhino to be relocated are removed in 1 year, the lst year of the simulations. It would be possible to investigate more graduated removals although the costs and logistics may not be feasible for such a strategy.

It is not possible in VORTEX to directly incorporate behavioral or social disruption due to removals. However, by considering the different, especially lower, rates of reproduction, some indication of the effects of any disruption can be obtained.

It is also not possible in VORTEX to remove specific individual animals from population. However, it is possible to designate the age and sex class of animals to be removed.

Applying the logic discussed in Section 6. D. of this document, a number of assumptions have been used for these scenarios:

- If 3 females are moved from Garamba, they might arguably be:
  3bF Juillet (Age 10-11)
  4cF Noel (Age 7-8)
  1cF Nawango (Age 4-5)
- If 2 females are moved from Garamba, they might arguably be:
  3bF Juillet (Age 10-11)
  4cF Noel (Age 7-8)
- If 3 males are moved from Garamba, they might arguably be:
  M4 Bac (Age > 20)
  M9 Notch (Age > 19)
  4aM Bolete moke (Age 11-12) or 1 Am Moke (12-13)
- If 2 males are moved from Garamba, they might arguably be:
  M4 Bac (Age > 20)
  M9 Notch (Age > 19)

10. B. POPULATION SIMULATIONS USING VORTEX GARAMBA POPULATION NORTHERN WHITE RHINO

RESULTS OF GARAMBA POPULATION SIMULATIONS

Expected Outcomes of the population simulations are reported through a number of demographic and genetic conditions of the population at the end of 25 Years and 50 Years.

Probability of Extinction — is technically the percentage of the 500 simulations during which the population went extinct. It can be interpreted as the risk that the real population with the parameters used would go extinct.

Mean Time to Extinction — is the average time to extinction for those populations out of the 500 that became extinct.

λ Lambda ($\approx$ r) — is the average annual rate of change in population numbers.
$\lambda > 0$ indicates the population will increase in size.
$\lambda = 0$ means the population will remain constant in size.
$\lambda < 0$ means the population will decrease in size.

These trends strictly apply only once a stable age distribution is attained which is not quite the case yet for the Garamba population but can occur quickly, especially when λ is relatively high; until then there can be some fluctuations in population numbers that may deviate from the general expectations.

Mean Final Population Size — is the average size of the 500 populations simulated in each scenario at the 25 and 50 year points.

Gene Diversity — is the expected heterozygosity in the population, one of the better overall measures of genetic variability.

BASIC SCENARIOS (Table 7)

Using the parameters as described, i.e. no significant poaching or removals for relocation, the future of the Garamba population appears healthy. (Table 7). The degree of health depends on:

- The mortality remaining low, which could change as the adult breeders classes continue to advance in age.
- The reproductive rate remaining high, which again could change as the adult female breeders advance in age and until/unless the subadults commence breeding.

The population numbers such as 198+ and 196+ for Mean Population Size at 50 years signifies that these populations would be larger, i.e. 1041 and 407 respectively, if the carrying capacity had not been artificially established at 200. Again, the carrying capacity was established at this level (1) to expedite the simulations (2) to acknowledge that an IPZ or sanctuary within Garamba with 200 rhino over the next 50 years is an objective with modest but perhaps feasible ambition.

EFFECTS OF CATASTROPHE (POACHING) SCENARIOS (Tables 8-9)

Moderate Episodic Poaching:

An episode of poaching 1 time every 10 years (frequency of the catastrophe) during which 25% of the rhino are lost (severity of the catastrophe) significantly reduces growth potential of the population so that the carrying capacity of 200 is not attained in the 50 year time period. (Table 8, upper half). If reproductive rates decline to half of their 1984-1995 levels, growth rates are very low and the effect on final population size at the end of 25 and 50 years is spectacular. The population barely increases in size and is at a 6-7% risk of becoming extinct

Severe Episodic Poaching:

An episode of poaching 1 time every 15 years during which 50% of the rhino are lost has appreciable risks (9-32%) of extinction at all levels of reproduction. Again if reproductive rates really decline, the effects are spectacular. (Table 8, lower half). After 50 years, the population is still about the same size but the λ is actually slightly negative which indicates that over the longer term the population numbers would decline. Again the frequency of this level of severe poaching is what has been observed in Garamba over the last 30 years, but the severity of poaching used in the simulation is actually lower than the decimation of the population that has actually occurred on these occasions.

Continuous Poaching:

At a Lower Level:

Continuous poaching that occurs every year and removes 3.5% of the population (at current population size equivalent to about 1 animal/year) significantly reduces population growth at the two higher levels of reproduction but the populations still are not at much risk of extinction and at least more than double their size. (Table 9, upper half). At the lowest level of reproduction investigated, the situation is different and the population actually declines and is on a course for certain extinction with a risk of 5-6% during the next 50 years.

At a Higher Level:

Continuous poaching that occurs every year and removes 7% of the population (at current population size equivalent to about 2 animals/year) has severe effects on the population with the population at zero growth rate even at the highest rate of reproduction. Extinction risks vary from 6 to 65%. (Table 9, lower half).

REMOVALS FOR RELOCATION TO A SECOND POPULATION (Tables 10-21)

Removals Under Basic Scenarios:

Both Sexes Removed:
The removal of rhino of both sexes for relocation does reduce the growth rate and mean population size (about 10-20% lower), but the source population stills grows healthily and there are no risks of extinction reported by the model. (Table 10; Compare Table 10 with Table 7) The effect of removing 6 (3 male/3 female) rhino versus 4 rhino (2 males/2 females) results in final population sizes about 20% lower versus 10% lower than if no removals occur.

Males Only Removed:
The removal of 3 male rhino for relocation appears to have virtually no effect on the prospects for the source population. (Table 11; Compare Table 11 with Table 7).

Removals Under Moderate Episodic Poaching:

Both Sexes Removed:
The removal of rhino of both sexes imposed on scenarios where moderate episodic poaching is occurring does reduce growth rates and mean final population sizes (10-20% lower) and increase extinction risks (about 30% higher) than when no removals occur. (Table 12; Compare Table 12 with upper half of Table 8). There is more impact if 6 (3.3) rather than 4 (2.2) rhino are removed. (Compare upper and lower halves of Table 12).

Males Only Removed:
The removal of 3 male rhino does not changed the results from the case when no removals occur (Table 13; Compare Table 13 with the upper half of Table 8).

Removals Under Severe Episodic Poaching:

Both Sexes Removed:
The removal of rhinos of both sexes imposed on scenarios where severe episodic poaching is occurring does decrease final population sizes (lower by about 10%) and increases risks of extinction (higher by 10-30%). (Table 14; Compare Table 14 with the lower half of Table 8). There are likewise somewhat higher risks of extinction if 6 rather than 4 rhino are removed. (Compare the upper and lower halves of Table 14).

Only Males Removed:
The removal of 3 male rhino has no effect on the results compared to the case when no removals occur. (Table 15; Compare Table 15 with lower half of Table 8).

Removals Under Continuous Poaching:

Lower Level:

Both Sexes Removed:
The removal of rhino of both sexes under continuous poaching at the lower level investigated does decrease growth rate and final population size (about 20% lower) and substantially increases the risk of extinction (50%) over the (Table 16; Compare Table 16 and upper half of Table 9). Removal of 6 rather than 4 rhinos has greater effect.

Males Only Removed:
The removal of 3 male rhino has no effect on the results compared to the case when no removals occur. (Table 17; Compare Table 17 with upper half of Table 9).

Higher Level:

Both Sexes Removed:
The removal of rhino of both sexes under continuous poaching at the higher level has the most significant effect on the prospects for the population, especially at the higher levels of reproduction. (Table 18; Compare Table 18 with the lower half of Table 9). The effect appears somewhat greater if 6 rather than 4 rhino are removed.

Males Only Removed:
The removal of 3 male rhino has no effect on the results compared to the case when no removals occur. (Table 19; Compare Table 13 with lower half of Table 9).

SUMMARY:

Removals of both sexes as high as the level of 3 males and 3 females when no poaching occurs do not appear to incur risks for the Garamba population.

Removal of rhino of both sexes increases risks to the Garamba population if rhino are removed if poaching is not controlled or reproduction is disrupted so it declines.

These results reinforce the importance of linking adequate and indeed improved protection of Garamba with any program of removals for relocation.

Removal of only males does not appear to increase risks for the Garamba population under the scenarios investigated.

It should be noted that the threats that have been investigated are not necessarily worst case scenarios.

In any case, the stakeholders and stewards formulate the strategy for northern white rhino, they must consider what the trade-offs are between the risks of removing rhino and not removing rhino from Garamba.

As the stakeholders and stewards continue the strategy formulation process, they can interactively investigate more scenarios.

10. C. POPULATION SIMULATIONS USING VORTEX NEWLY ESTABLISHED POPULATIONS NORTHERN WHITE RHINO

SCENARIOS INVESTIGATED & INPUT PARAMETERS USED

All simulations have been performed with 500 runs.

FOUNDERS ENTIRELY FROM CAPTIVE POPULATION (Table 20):

The scenarios examine consolidation of the captive population supposing that reproduction can be stimulated to occur at one of the levels considered in the basic scenarios for the Garamba population , i.e.:

- 40% females producing in any 1 year = intercalf interval of 2.5 years
- 30% females producing in any 1 year = intercalf interval of 3.3 years
- 20% females producing in any 1 year = intercalf interval of 5.0 years

The scenarios examine all combinations (6 scenarios) of these levels of reproduction with two levels of adult mortality:

- 3%/year, i.e. the Garamba value.
- 5%/year, i.e. a value not quite twice as high as the Garamba value.

FOUNDERS ENTIRELY FROM GARAMBA POPULATION (Table 21):

These scenarios consider the fate a new population established by relocation of 6 (3.3) rhino from Garamba National Park under three levels of reproduction and two levels of adult mortality (6 scenarios):

- Two levels of adult mortality:
  - 3%/year, i.e. equivalent to 1 death every 3-4 years.
  - 5%/year, i.e. equivalent to 1 death every other year.
- Three levels of reproduction:
  - 40% females producing in any 1 year = intercalf interval of 2.5 years
  - 30% females producing in any 1 year = intercalf interval of 3.3 years
  - 20% females producing in any 1 year = intercalf interval of 5.0 years

FOUNDERS FROM COMBINATIONS OF CAPTIVE AND GARAMBA POPULATION:

These scenarios examine fates of new populations established with various numbers of rhino from Garamba and the captive population under the three levels of reproduction and two levels of adult mortality considered in previous scenarios (36 scenarios).

Combination 1 (Table 22):

- 9 (4.5) rhino from captivity
- 6 (3.3) rhino from Garamba (3 males > 10 yr; 1 ♀ = 4-5 yr, 1 ♀ 7-8 yr, 1 ♀ 10-11 yr)

Combination 2 (Table 23):

- 9 (4.5) rhino from captivity
- 4 (2.2) rhino from Garamba (2 males > 10 yr; 1 ♀ 7-8 yr, 1 ♀ 10-11 yr)

Combination 3 (Table 24):

- 9 (4.5) rhino from captivity
- 3 (3.0) rhino from Garamba (3 males > 10 yr)

Combination 4 (Table 25):

- 4 (2.2) rhino from captivity (1 ♂ 15-16 yr, 1 ♂ 22-23 yr; 2 ♀♀ < 20 yr)
- 6 (3.3) rhino from Garamba (3 ♂♂ > 10 yr; 1 ♀ = 4-5 yr, 1 ♀ 7-8 yr, 1 ♀ 10-11 yr)

Combination 5 (Table 26):

- 4 (2.2) rhino from captivity (1 ♂ 15-16 yr, 1 ♂ 22-23; 2 ♀♀ < 20 yr)
- 4 (2.2) rhino from Garamba (2 ♂♂ > 10 yr; 1 ♀ 7-8 yr, 1 ♀ 10-11 yr)

Combination 6 (Table 27):

- 3 (0.3) rhino from captivity (3 ♀♀ < 22 yr)
- 3 (3.0) rhino from Garamba (3 ♂♂ > 10 yr)

It is also not possible in VORTEX to specify individual animals as founders for a new population. However, it is possible to designate the age and sex class of animals to be removed.

Again applying the logic of Section 6. D. of this Document, it has been assumed:

- If 3 females from Garamba are founders (Combinations 1 & 4), they might arguably be:
  3bF Juillet (Age 10-11)
  4cF Noel (Age 7-8)
  1cF Nawango (Age 4-5)
- If only 2 females from Garamba are founders (Combinations 2 & 5), they might arguably be:
  3bF Juillet (Age 10-11)
  4cF Noel (Age 7-8)
- If 3 males from Garamba are founders (Combinations 1,3,4, & 6) they might arguably be:
  M4 Bac (Age > 20)
  M9 Notch (Age > 19)
  4aM Bolete moke (Age 11-12) or 1 Am Moke (Age 12-13)
- If 2 males from Garamba are founders (Combinations 2 & 5), they might arguably be:
  M4 Bac (Age > 20)
  M9 Notch (Age > 19)
- If only 3 females from captivity are founders (Combination 6), they might arguably be:
  789 Nabire (Age 11-12)
  943 Najin (Age 6-7)
  374 Nola (If her medical condition is resolved satisfactorily) (Age 19)
  or
  376 Nadi (Age 23)
- If only 2 females from captivity are founders (Combination 4 & 5), they might arguably be:
  789 Nabire (Age 11-12)
  943 Najin (Age 6-7)
- If only 2 males from captivity are founders (Combinations 4 & 5), they might arguably be:
  630 Suni (a young male Age 15-16 at Dvur Kralove)
  373 Saut (a proven breeder Age 23 at San Diego)

10. D. POPULATION SIMULATIONS USING VORTEX NEWLY ESTABLISHED POPULATIONS

RESULTS OF NEW POPULATION SIMULATIONS POPULATIONS

Expected Outcomes of the population simulations are reported through a number of demographic and genetic conditions of the population at the end of 25 Years and 50 Years.

Probability of Extinction — is technically the percentage of the 500 simulations during which the population went extinct. It can be interpreted as the risk that the real population with the parameters used would go extinct.

Mean Time to Extinction — is the average time to extinction for those populations out of the 500 that became extinct.

λ Lambda ($\approx$ r) — is the average annual rate of change in population numbers.
$\lambda > 0$ indicates the population will increase in size.
$\lambda = 0$ means the population will remain constant in size.
$\lambda < 0$ means the population will decrease in size.

These trends strictly apply only once a stable age distribution is attained which is not quite the case yet for the Garamba population but can occur quickly, especially when λ is relatively high; until then there can be some fluctuations in population numbers that may deviate from the general expectations.

Mean Final Population Size — is the average size of the 500 populations simulated in each scenario at the 25 and 50 year points.

Gene Diversity — is the expected heterozygosity in the population, one of the better overall measures of genetic variability.

FOUNDERS ENTIRELY FROM CAPTIVE POPULATION (Table 20):
The prospects for new populations established by consolidating and perhaps relocating all 9 (4 male and 5 female) northern white rhino in captivity are good if the rates of mortality and reproduction prevailing in Garamba are attained. The prospects decline as the rates of reproduction decrease and rates of mortality increase. Considering the past performance of this group reproductively only the middle and perhaps lowest reproductive rates are to be expected.

FOUNDERS ENTIRELY FROM GARAMBA (Table 21):
The prospects for a new population established by 6 (3 male and 3 female) appear good if the same rates of reproduction and mortality that prevail in Garamba can be attained. However, the projections are slightly worse than for a population founded by all 9 rhino from captivity for the same input parameters. The reason presumably is simply the smaller number of founding females exposing the population to more risks of random fluctuations. It is also probably more reasonable to assume that the younger rhino that presumably would be moved from Garamba might achieve the higher rates of reproduction and lower rates of mortality than the captive rhino with many individuals advanced in age and perhaps having some medical problems already.

FOUNDERS FROM A COMBINATION OF CAPTIVE AND GARAMBA POPULATIONS (Tables 22-27):

The best prospects prevail when all the captive rhino and 6 of the Garamba rhino are combined to found a new population (Combination 1; Table 22).

More generally, results are best when total number of females is highest and they include the two youngest females from captivity and at least 2 females from Garamba. (Combinations 16, 17, and 19; Tables 22, 23, 24)

All of these results are better than populations founded with only captive (Table 20) or only Garamba rhino (Table 21) found the population.

Adding 3 males from Garamba to all rhino from captivity is marginally better than using just the captives. However, these simulations assume that the captive males will impregnate females as well as Garamba males will. This assumption may not be valid.

The worst results occur when only Garamba rhino and only females from captivity and males from Garamba are used. But again, these simulations presume that Garamba and captive rhino are equally likely to reproduce which may not be valid.

As would be expected, in all cases the higher the reproduction and the lower the mortality the better the results. Reproduction at the intermediate level (i.e. an intercalf interval of 3.3 years) and mortality at the lower (3%) level seems important to keep probability of extinction below 10% and to attain population sizes > 100 over the 50 year period.

TABLE 7

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA

BASIC SCENARIOS - NO POACHING - NO REMOVALS

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Basic No Poaching No Moves	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14			0 0		173 198+	97 96
	28 14.14	3%	30 (3.3 Yr)	5.5					3.14			0 0		113 196+	97 96
	28 14.14	3%	20 (5 Yr)	3					3.14			0 0		65 126	96 97

TABLE 8

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA

EFFECTS OF EPISODIC POACHING AT MODERATE AND SEVERE LEVELS

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Episodic Moderate Poaching	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	4.8	.1 = every 10yr	25% Killed			3.14			0 0		95 157	96 94
	28 14.14	3%	30 (3.3 Yr)	2.9	.1 = every 10yr	25% Killed			3.14			0 .6	41	61 103	95 93
	28 14.14	3%	20 (5 Yr)	.4	.1 = every 10yr	25% Killed			3.14			.6 6.6	39	35 37	94 89
Episodic Severe Poaching	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	3.9	.067 every 15 yr	50% Killed			3.14			3 8.6	30	72 108	93 91
	28 14.14	3%	30 (3.3 Yr)	2	.067 every 15 yr	50% Killed			3.14			5.0 15.4	32	48 64	93 89
	28 14.14	3%	20 (5 Yr)	-.5	.067 every 15 yr	50% Killed			3.14			9.2 32.4	33	29 30	91 86

TABLE 9

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA

EFFECTS OF CONTINUOUS POACHING AT A LOWER AND A HIGHER LEVEL

POPULATION PARAMETERS					CATASTROPHIES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Continuous Poaching At Lower Level	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	3.8	1 i.e., every year	3.5% Killed curntly would be 1/yr.			3.14			0 0		74 152	96 94
	28 14.14	3%	30 (3.3 Yr)	1.8	1	3.5% Killed			3.14			0 .2		47 67	95 92
	28 14.14	3%	20 (5 Yr)	-.6	1	3.5% Killed			3.14			.2 5.6	43	26 21	94 87
Continuous Poaching At Higher Level	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	1	1 i.e., every year	7% Killed curntly would be 2/yr.			3.14			.4 6.4	41	29 26	92 85
	28 14.14	3%	30 (3.3 Yr)	-2	1	7% Killed			3.14			1 24	41	18 11	91 80
	28 14.14	3%	20 (5 Yr)	-4.3	1	7% Killed			3.14			6 65	37	11 6	88 74

TABLE 10

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA POPULATION

EFFECT OF REMOVAL OF BOTH SEXES FOR NEW POPULATION - NO POACHING

POPULATION PARAMETERS					CATASTROPHIES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
No Poaching 6 (3.3) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14	6 (3.3)	1	0 0		145 198+	96 96
	28 14.14	3%	30 (3.3 Yr)	5.5					3.14	6 (3.3)	1	0 0		91 193+	96 95
	28 14.14	3%	20 (5 Yr)	3					3.14	6 (3.3)	1	0 0		53 99	96 94
No Poaching 4 (2.2) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14	4 (2.2)	1	0 0		155 199+	97 96
	28 14.14	3%	30 (3.3 Yr)	5.5					3.14	4 (2.2)	1	0 0		99 194+	96 96
	28 14.14	3%	20 (5 Yr)	3					3.14	4 (2.2)	1	0 0		57 108	96 95

TABLE 11

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA POPULATION

EFFECT OF REMOVAL OF MALES ONLY FOR NEW POPULATION - NO POACHING

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Number	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
No Poaching 3 (3.0) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14	3 (3.0)	1	0 0		171 197+	97 96
	28 14.14	3%	30 (3.3 Yr)	5.5					3.14	3 (3.0)	1	0 0		113 196+	96 96
	28 14.14	3%	20 (5 Yr)	3					3.14	3 (3.0)	1	0 0		64 123	96 95

TABLE 12

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA POPULATION

EFFECT OF REMOVAL OF BOTH SEXES FOR NEW POPULATION - EPISODIC MODERATE POACHING

POPULATION PARAMETERS					CATASTROPHIES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Episodic Moderate Poaching 6 (3.3) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	4.8	.1 = every 10yr	25% Killed			3.14	6 (3.3)	1	0 .2	44	81 152	95 94
	28 14.14	3%	30 (3.3 Yr)	2.9	.1 = every 10yr	25% Killed			3.14	6 (3.3)	1	0 .8	42	48 81	94 91
	28 14.14	3%	20 (5 Yr)	.4	.1 = every 10yr	25% Killed			3.14	6 (3.3)	1	1 7.4	36	29 29	93 87
Episodic Moderate Poaching 4 (2.2) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	4.8	.1 = every 10yr	25% Killed			3.14	4 (2.2)	1	0 .4	37	80 151	95 94
	28 14.14	3%	30 (3.3 Yr)	2.9	.1 = every 10yr	25% Killed			3.14	4 (2.2)		.6 1.2	27	52 88	94 92
	28 14.14	3%	20 (5 Yr)	.4	.1 = every 10yr	25% Killed			3.14	4 (2.2)		1 5.2	37	30 33	93 88

TABLE 13

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA POPULATION

EFFECT OF REMOVAL OF MALES ONLY FOR NEW POPULATION - EPISODIC MODERATE POACHING

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Episodic Moderate Poaching 3 (3.0) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	4.8	.1 = every 10yr	25% Killed			3.14	3 (3.0)	1	0 .4	30	97 160	95 94
	28 14.14	3%	30 (3.3 Yr)	2.9	.1 = every 10yr	25% Killed			3.14	3 (3.0)	1	.2 .6	34	62 102	95 93
	28 14.14	3%	20 (5 Yr)	.4	.1 = every 10yr	25% Killed			3.14	3 (3.0)	1	.8 5.2	36	34 37	94 89

TABLE 14

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA POPULATION

EFFECT OF REMOVAL OF BOTH SEXES FOR NEW POPULATION - EPISODIC SEVERE POACHING

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Episodic Severe Poaching 6 (3.3) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	3.9	.067 every 15 yr	50% Killed			3.14	6 (3.3)	1	5.2 9.8	26	65 96	93 90
	28 14.14	3%	30 (3.3 Yr)	2	.067 every 15 yr	50% Killed			3.14	6 (3.3)	1	5.2 15.4	31	43 65	92 88
	28 14.14	3%	20 (5 Yr)	-.5	.067 every 15 yr	50% Killed			3.14	6 (3.3)	1	13.0 34.8	30	25 28	91 85
Episodic Severe Poaching 4 (2.2) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	3.9	.067 every 15 yr	50% Killed			3.14	4 (2.2)	1	5.4 11.2	29	66 96	93 90
	28 14.14	3%	30 (3.3 Yr)	2	.067 every 15 yr	50% Killed			3.14	4 (2.2)	1	5.6 17	31	45 62	92 88
	28 14.14	3%	20 (5 Yr)	-.5	.067 every 15 yr	50% Killed			3.14	4 (2.2)	1	9.8 33.0	32	25 26	90 84

TABLE 15

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA POPULATION

EFFECT OF REMOVAL OF MALES ONLY FOR NEW POPULATION - EPISODIC SEVERE POACHING

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Episodic Severe Poaching 3 (3.0) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	3.9	.067 every 15 yr	50% Killed			3.14	3 (3.0)	1	2.6 8.4	31	75 102	93 90
	28 14.14	3%	30 (3.3 Yr)	2	.067 every 15 yr	50% Killed			3.14	3 (3.0)	1	6.4 14.6	28	51 70	92 89
	28 14.14	3%	20 (5 Yr)	-.5	.067 every 15 yr	50% Killed			3.14	3 (3.0)	1	8.0 27.6	32	30 31	91 85

TABLE 16

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA POPULATION

EFFECT OF REMOVAL OF BOTH SEXES FOR NEW POPULATION - CONTINUOUS POACHING LOWER LEVEL

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Continuous Poaching At Lower Level 6 (3.3) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	3.8	1 i.e., every year	3.5% Killed curntly would be 1/yr.			3.14	6 (3.3)	1	0 0		58 125	94 93
	28 14.14	3%	30 (3.3 Yr)	1.8	1	3.5% Killed			3.14	6 (3.3)	1	0 0		37 51	93 90
	28 14.14	3%	20 (5 Yr)	-.6	1	3.5% Killed			3.14	6 (3.3)	1	.4 8.6	41	21 17	92 85
Continuous Poaching At Lower Level 4 (2.2) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	3.8	1 i.e., every year	3.5% Killed curntly would be 1/yr.			3.14	4 (2.2)	1	0 .2	49	61 129	95 93
	28 14.14	3%	30 (3.3 Yr)	1.8	1	3.5% Killed			3.14	4 (2.2)	1	0 .2	33	40 57	94 91
	28 14.14	3%	20 (5 Yr)	-.6	1	3.5% Killed			3.14	4 (2.2)	1	0 6.4	41	23 19	93 86

TABLE 17

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA POPULATION

EFFECT OF REMOVAL OF MALES ONLY FOR NEW POPULATION - CONTINUOUS POACHING AT LOWER LEVEL

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Continuous Poaching At Lower Level 3 (3.0) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	3.8	1 i.e., every year	3.5% Killed curntly would be 1/yr.			3.14	3 (3.0)	1	0 0		74 155	95 94
	28 14.14	3%	30 (3.3 Yr)	1.8	1	3.5% Killed			3.14	3 (3.0)	1	0 0		47 67	94 92
	28 14.14	3%	20 (5 Yr)	-.6	1	3.5% Killed			3.14	3 (3.0)	1	.2 2	42	26 22	93 88

TABLE 18

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA POPULATION

EFFECT REMOVAL OF BOTH SEXES FOR NEW POPULATION - CONTINUOUS POACHING HIGHER LEVEL

POPULATION PARAMETERS					CATASTROPHIES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Continuous Poaching At Higher Level 6 (3.3) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	1	1 i.e., every year	7% Killed curntly would be 2/yr.			3.14	6 (3.3)	1	1.2 11.2	38	23 21	90 82
	28 14.14	3%	30 (3.3 Yr)	-1.9	1	7% Killed			3.14	6 (3.3)	1	2.6 37.0	39	15 10	88 76
	28 14.14	3%	20 (5 Yr)	-4.3	1	7% Killed			3.14	6 (3.3)	1	13 74	35	9 5	85 70
Continuous Poaching At Higher Level 4 (2.2) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	1	1 i.e., every year	7% Killed curntly would be 2/yr.			3.14	4 (2.2)	1	1.6 10.4	37	24 21	91 83
	28 14.14	3%	30 (3.3 Yr)	-1.9	1	7% Killed			3.14	4 (2.2)	1	2.4 32.4	39	16 10	89 78
	28 14.14	3%	20 (5 Yr)	-4.3	1	7% Killed			3.14	4 (2.2)	1	11.4 71.8	35	9 5	89 70

TABLE 19

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA POPULATION

EFFECT OF REMOVAL OF MALES ONLY FOR NEW POPULATION - CONTINUOUS POACHING AT HIGHER LEVEL

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Continuous Poaching At Higher Level 3 (3.0) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	1	1 i.e., every year	7% Killed curntly would be 2/yr.			3.14	3 (3.0)	1	.6 5.8	42	29 26	92 85
	28 14.14	3%	30 (3.3 Yr)	-1.9	1	7% Killed			3.14	3 (3.0)	1	1.2 25.0	40	18 12	90 79
	28 14.14	3%	20 (5 Yr)	-4.3	1	7% Killed			3.14	3 (3.0)	1	5.6 65.8	38	11 6	87 73

TABLE 20

NORTHERN WHITE RHINO POPULATION SIMULATIONS - NEW POPULATION

FOUNDERS ENTIRELY FROM CAPTIVE POPULATION

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
9 (4.5) Captivity	9 4.5	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14			0 0		60 184+	91 90
		3%	30 (3.3 Yr)	5.5					3.14			.2 .4	27	35 110	89 88
		3%	20 (5 Yr)	3.0					3.14			.8 3.6	32	17 36	88 84
		5% (1 per 2 yrs)	40 (2.5 Yr)	6.4					3.14			.4 .6	23	47 149	89 88
		5%	30 (3.3 Yr)	4.3					3.14			1.0 3.4	33	27 61	87 85
		5%	20 (5 Yr)	1.7					3.14			4.6 14.6	31	14 19	85 79

TABLE 21

NORTHERN WHITE RHINO POPULATION SIMULATIONS - NEW POPULATION

FOUNDERS ENTIRELY FROM GARAMBA POPULATION

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
6 (3.3) Garamba	6 3.3	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14			.6 .8	14	35 140	86 85
		3%	30 (3.3 Yr)	5.5					3.14			2.6 4.0	24	23 68	84 82
		3%	20 (5 Yr)	3.0					3.14			3.4 11.2	30	13 23	83 77
		5% (1 per 2 yrs)	40 (2.5 Yr)	6.4					3.14			2.2 3.2	19	27 90	84 81
		5%	30 (3.3 Yr)	4.3					3.14			4.6 9.4	26	17 36	82 77
		5%	20 (5 Yr)	1.7					3.14			15.2 35.4	28	10 14	80 73

TABLE 22

NORTHERN WHITE RHINO POPULATION SIMULATIONS - NEW POPULATION

FOUNDERS FROM COMBINATION OF CAPTIVE AND GARAMBA POPULATIONS - COMBINATION 1

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
9 (4.5) Captivity 6 (3.3) Garamba	15 7.8	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14			0 0		101 198+	94 94
		3%	30 (3.3 Yr)	5.5					3.14			0 0		63 173+	94 93
		3%	20 (5 Yr)	3.0					3.14			0 0		34 64	93 91
		5% (1 per 2 yrs)	40 (2.5 Yr)	6.4					3.14			0 0		78 187+	94 93
		5%	30 (3.3 Yr)	4.3					3.14			0 0		48 115	93 91
		5%	20 (5 Yr)	1.7					3.14			.4 3.2	36	25 35	91 87

TABLE 23

NORTHERN WHITE RHINO POPULATION SIMULATIONS - NEW POPULATION

FOUNDERS FROM COMBINATION OF CAPTIVE AND GARAMBA POPULATIONS - COMBINATION 2

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
9 (4.5) Captivity 4 (2.2) Garamba	13 6.7	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5	1 i.e., every year	3.5% Killed curntly would be 1/yr.			3.14			0 0		92 196+	94 93
		3%	30 (3.3 Yr)	5.5	1	3.5% Killed			3.14			0 0		55 159	93 92
		3%	20 (5 Yr)	3.0	1	3.5% Killed			3.14			0 .4	32	29 55	91 89
		5% (1 per 2 yrs)	40 (2.5 Yr)	6.4	1	3.5% Killed			3.14			0 0		69 178+	93 92
		5%	30 (3.3 Yr)	4.3	1	3.5% Killed			3.14			.2 1	31	40 100	91 90
		5%	20 (5 Yr)	1.7	1	3.5% Killed			3.14			1.4 5.4	35	20 29	89 85

TABLE 24

NORTHERN WHITE RHINO POPULATION SIMULATIONS - NEW POPULATION

FOUNDERS FROM COMBINATION OF CAPTIVE AND GARAMBA POPULATIONS - COMBINATION 3

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
9 (4.5) Captivity 3 (3.0) Garamba	12 7.5	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14			0 0		62 188+	92 92
		3%	30 (3.3 Yr)	5.5					3.14			0 .2	41	38 122	91 90
		3%	20 (5 Yr)	3.0					3.14			.4 2	33	21 38	90 86
		5% (1 per 2 yrs)	40 (2.5 Yr)	6.4					3.14			.4 .4	17	46 147	91 90
		5%	30 (3.3 Yr)	4.3					3.14			1.2 2.4	27	29 70	90 87
		5%	20 (5 Yr)	1.7					3.14			4.8 12.6	31	15 21	87 81

TABLE 25

NORTHERN WHITE RHINO POPULATION SIMULATIONS - NEW POPULATION

FOUNDERS FROM COMBINATION OF CAPTIVE AND GARAMBA POPULATIONS - COMBINATION 4

POPULATION PARAMETERS					CATASTROPHIES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
4 (2.2) Captivity 6 (3.3) Garamba	10 5.5	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14			0 .2	30	68 190	92 91
		3%	30 (3.3 Yr)	5.5					3.14			0 0		42 127	91 89
		3%	20 (5 Yr)	3.0					3.14			0 1	34	24 43	90 86
		5% (1 per 2 yrs)	40 (2.5 Yr)	6.4					3.14			0 .2	50	48 149	90 88
		5%	30 (3.3 Yr)	4.3					3.14			.2 1.4	32	31 73	89 86
		5%	20 (5 Yr)	1.7					3.14			2.2 9.0	33	17 24	87 82

TABLE 26

NORTHERN WHITE RHINO POPULATION SIMULATIONS - NEW POPULATION

FOUNDERS FROM COMBINATION OF CAPTIVE AND GARAMBA POPULATIONS - COMBINATION 5

Description of Scenario Modelled	POPULATION PARAMETERS				CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
4 (2.2) Captivity 4 (2.2) Garamba	8 (4.4)	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14			0 0		54 175+	90 89
		3%	30 (3.3 Yr)	5.5					3.14			.2 .2	12	34 102	88 87
		3%	20 (5 Yr)	3.0					3.14			.2 4.8	30	18 33	87 82
		5% (1 per 2 yrs)	40 (2.5 Yr)	6.4					3.14			.4 .8	32	39 129	88 86
		5%	30 (3.3 Yr)	4.3					3.14			1.8 3.2	24	25 56	86 83
		5%	20 (5 Yr)	1.7					3.14			5.2 19.4	33	13 18	83 77

TABLE 27

NORTHERN WHITE RHINO POPULATION SIMULATIONS - NEW POPULATION

FOUNDERS FROM COMBINATION OF CAPTIVE AND GARAMBA POPULATIONS - COMBINATION 6

POPULATION PARAMETERS					CATASTROPHES					REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	INBRD (Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
3 (0.3) Captivity 3 (3.0) Garamba	6 (3.3)	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14			.8 1	19	36 139	86 85
		3%	30 (3.3 Yr)	5.5					3.14			1.6 2.0	20	23 66	85 82
		3%	20 (5 Yr)	3.0					3.14			5.8 13.6	28	13 22	83 78
		5% (1 per 2 yrs)	40 (2.5 Yr)	6.4					3.14			2.6 3.6	17	27 86	84 81
		5%	30 (3.3 Yr)	4.3					3.14			9.2 14.8	22	17 37	82 78
		5%	20 (5 Yr)	1.7					3.14			15.0 34.2	28	11 15	80 73

10. E. POPULATION SIMULATIONS USING SPARKS/GENES/DEMOG GARAMBA POPULATION OF NORTHERN WHITE RHINO

Since VORTEX does not permit investigation of the effects of removal of specific individuals from Garamba, a "studbook" has been created from the data available on the age-sex structure and the pedigree of this population. It is envisioned that this "studbook" can be used with the captive population management software to better examine the effects of relocation of specific individuals from the Garamba population. These analyses will best be done interactively as the strategy process continues.